

# THE EFFECTIVE USE OF LOGBOOKS IN UNDERGRADUATE CLASSES

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Substantial writing assignments are required in an increasing number of undergraduate technical courses. They are usually intended to give the students practice in formal written communication, which will probably be an important part of the jobs most of them will choose after graduation.

With these jobs in mind, the assignments tend to concentrate on teaching the students to write formal reports and polished memos, two common forms of professional writing. Not all of the important professional writing that students will do in future jobs will be in these commonly emphasized formats.

This article discusses a semester-long writing assignment, the class-related logbook, that concentrates on teaching the process of using regular writing as a powerful professional tool apart from the formal documents required on the job. The assignment itself will be discussed in the format it has taken after three successful years of implementation in the first junior-level transport class for chemical engineering majors where class sizes ranged from fourteen to thirty-three students.

The need for this innovative logbook assignment evolved partly from the changing undergraduate engineering curriculum. Engineering students once took more hours of undergraduate laboratory courses and were required to keep lab notebooks. These notebooks were graded according to rigid rules concerning completeness, organization, and clarity. Currently, the trend in many schools is away from these laboratory courses, for a variety of reasons including expense, safety, intensity of instructional resources, and logistics of fitting all the current requirements into shrinking credit-hour limits.

While some parts of the laboratory experience can be replaced by computer simulations, writing as a tool of organization, planning, and discovery that was inherent in good

laboratory notebooks seems to have fallen from the curriculum. The class-related logbook revives this use of writing as a technical tool.

There are also sound pedagogical reasons for including writing assignments in addition to the typical formal reports and memos. Writing can be a powerful tool for information processing: for assimilation, for organization, for clarification, for analysis, and for synthesis. In short, all levels of higher-order cognitive learning (as outlined in Bloom's Taxonomy,<sup>[1]</sup> for example), can be more efficiently achieved with good personal writing skills as tools.

Since we want our students to be lifelong learners, this habit of using writing as a problem-solving tool should be taught and practiced in conjunction with their classroom experiences, just as their other intellectual tools such as calculus, computer literacy, and the ability to produce formal documents are.

The idea of class-related logbooks sounds like a simple and laudable way to develop valuable personal writing habits early in the undergraduate career, but there are certain pitfalls to successful implementation of the practice. This article includes ways of avoiding three of the most common pitfalls: unrealistic professorial expectations, inadequate assignment design and presentation, and ineffectual grading practices.



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## THE ASSIGNMENT

The class-related logbook assignment consists of three required sections: a journal, chapter outlines, and reference pages. (Students have the option of adding other sections for their own use, but seldom do.) Each section has an individual function and format. When combined, the whole logbook is an integrated study tool demonstrating the interrelationship among different components. The logbook is graded and makes up a little under ten percent of the student's grade, enough to insure that they do the assignment but not enough that they overemphasize it to the detriment of their other learning tasks.

Table 1 (next page) shows an actual class handout given to the students explaining the assignment. This written definition of the logbook assignment includes general guidelines for informal professional writing, instructions for each of the sections, and examples of acceptable journal entries. Students

are advised in writing, via this document, that while the logbook is theirs, it will be a "semipublic document," and parts of it may be shared in a professional manner with the class as a whole or with other academicians. They are verbally assured that this public sharing will not include the explicit identification of individuals without their consent and any requests for confidentiality will be honored.

The purpose of the journal is threefold: to encourage habitual writing as an organizational tool, to teach the use of chronological records as measurements of progress and as indicators of patterns, and to give students a regular opportunity to communicate with the instructor concerning the course and their progress. Anything relevant to the class can be included: their insights, their questions on procedure or content, their personal methods or circumstances that legitimately influence their class performance or their learning experiences. Honesty is required (although they are not required to bare their souls). Special assignments are required throughout the semester to help structure the journal, as will be discussed below. Instructor feedback on the journal is the key to success in developing the good writing and communication habits the journal is designed to foster.

The purpose of the chapter outlines is to demonstrate to the students the strengths of this traditional and effective study tool—one that seems to be falling by the wayside in popularity without being replaced by anything that has been

demonstrated to be as effective and as simple. Students who stay current on their chapter outlines will read the assignments in a timely manner and will usually read more thoroughly. Instructor feedback on these outlines is a valuable tool in helping them hone their abilities to prioritize and to understand how others have organized material. The outlines themselves are useful tools for studying for tests and for taking open-book tests.

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The reference pages are the students' own organizational products, tailored to their individual needs. These pages contain the highlights of the key concepts presented in the course, as well as any useful information from other courses. A typical set of reference pages might include a page of important dimensionless numbers, with defining equations as well as a few words about the physical meaning and applications, a page or two of named equations and key definitions, and a page of "reminders" with a few

facts from a math course or useful variables such as the viscosity of air and water at standard conditions. There may also be a brief annotated bibliography or a list of particularly useful reference sources.

Unlike the journals, which are chronological, and the outlines, which are dictated by someone else's organizational style, the reference pages are an opportunity for the students to learn how they can most effectively organize material for themselves. Supplemental material (usually from previous classes) is often included in the best examples of these pages. They are also useful tools for studying and taking tests. The reference pages are usually quite compact, and therefore the students will find them to be the most useful summary of the course. They are often used to review key concepts when students take subsequent courses or when they study for comprehensive exams, such as professional licensing exams.

## COMMON PITFALLS: HOW TO AVOID THEM

### *Pitfall 1: Unrealistic Professorial Expectations*

One of my colleagues tried using my logbook assignment and gave up a few weeks into the semester. He found that the good students will keep good logbooks, but similarly, the students who didn't do the other assignments kept bad logbooks if they kept them at all. He concluded that the logbooks weren't serving his purpose of making the

## TABLE 1: CLASS HANDOUT FOR LOGBOOKS

**What?** You will be required to keep a logbook for this class. The logbook will be yours, so you have some freedom in what you put in it and how. It is, however, a “semipublic document,” so there are some requirements and guidelines. I will read it on a regular basis and we may share parts of it formally in class. I may make copies of part or all of some of the logbooks for use in the future.

**Why?** The purpose of this logbook is communication. It is an ongoing written progress report of your work. It will let me know how the class is progressing; it will let you see your progress and may help you in seeing patterns to accelerate or ease that progress. Logbooks are also powerful tools in the real world (see Clifford Stoll’s *The Cuckoo’s Egg*, a true thriller where a physicist cracks an international computer spy ring and convicts the spies because his logbooks are used as documentation in court).

**How?** A three-ring binder with dividers?

### Guidelines and Requirements

- It must be legible and understandable.
- The writing should be professional but not necessarily polished. Be clear, concise, specific, and accurate. Be natural, but not too relaxed. (Do not use language you would not use in front of a significant other’s parents the first time you meet them, for example.) Grammar need not be perfect (Contractions and sentence fragments are okay.) Active voice is preferred.
- It should be scrupulously honest. (Recall that honest does not necessarily mean exhaustive. Everything you say should be true, but you needn’t say everything.) You are not being graded on how easily or independently you pick up material outside of class or whether or not you like the subject or class.
- Every entry should be dated
- The logbook will have at least three sections: the journal, the chapter outlines, and the reference pages.

**The Journal** • This is the most free-form section. There will be some specific questions and topics assigned for discussion, and these must be addressed in a professional manner in the journal, within the time frames specified. They should also be clearly marked. In addition to these assignments, anything that relates to this class belongs in this section. It should not contain irrelevant thoughts, but tangential thoughts are okay. How you study for the class, what works well, what doesn’t, why and how it works (or doesn’t) can go in; with whom you study is okay; why you couldn’t study (not excuses, but reasons); what was good or bad or frustrating or boring or interesting or hard or easy about the day’s class or homework problems or reading assignment (The more specific details, the more useful such entries will be for both you and me.); a supplementary source you found particularly useful; a connection with something in another class or some personal experience; a worked-out example or scratched notes on problem approaches might be included. You will find it useful to summarize periodically. An example of a journal is attached.

**Chapter Outlines** • This is your personal annotated index of the important parts of the textbook. Construct it in a way that is useful to you. You may want to emphasize points that were difficult for you, de-emphasizing the “intuitively obvious” subjects, even if those subjects are treated extensively in the book. Cross-reference ideas and equations to pages in the text. You may also want to cross-reference pages in your notes or other materials. A page or two should be enough to hit the important ideas in each chapter. Keep in mind that properly constructed outlines can be very useful study guides and invaluable for taking open-book tests.

**Reference Pages** • This section will contain things like a bibliography, the list of named equations, key concepts, charts, etc. Organize this section in a way that is logical to you, not just by chronological order in book or course notes. This section, too, can be invaluable for taking open-book tests.

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### A Sample Journal (Based on Student Journals in a Fluid Mechanics Class)

9/15—worked this afternoon with Scott C. and Jason B. for two hours on problem 3-15. Brick wall! After dinner, reviewed lecture notes for 9/9 while waiting for the laundry. THIS IS THE SAME PROBLEM EXCEPT IN SPHERICAL COORDINATES!

9/16—No clue what that lecture meant! When can you assume what for boundary conditions? It seems so arbitrary. How do you know where to put the origins? And, of course I could have answered any other class question today, except the one she asked me! How does she always pick the part of the reading I didn’t get to to ask me?

ASSIGNED DISCUSSION “Write directions for designing and making an Egyptian water clock. The explanations of what you are doing and why should be clear, accurate, and concise, and easily understood by a bright 12th grade science class. Sketches and equations may be useful.” [...Two pages of discussion omitted from logbook example...]

9/17—No way am I going to torture myself with that stupid stuff on a Friday night!

9/20—I just know there will be a quiz tomorrow. Always is when we have big assignments due in thermo. Will it be vocabulary or math? I only have time to study one! Scott and Jason came over and we worked for about four hours on 3-11. Another hour just getting the details on 3-15. Too much work! And where are the physical properties at that temperature? I just want to stop pollution, not write differential equations. So I’ll review vocabulary lists from Chapter 1-3 (in my reference pages).

9/21—I guessed right. Vocabulary quiz. I think I did okay. At least I finally have the difference between continuity and continuum down. Karyn said she and Skylar only needed three hours for the whole homework set. They used White’s book (on reserve in the library) because it has a good summary of when to apply boundary conditions and the viscosities and densities are in Perry’s! Wish I’d known. Jim asked how to know when to use which boundary conditions. “Experience” was the answer—so what do we do, take the class five times? Still, when we broke into small groups to do b.c.’s for the examples, I got most of them right by the end of group time. Small group work seems like an effective way to “experience” stuff like this.

9/22—So if there is a no-slip condition at a wall, and you can get non-symmetric velocity profiles with plates moving at different conditions, is this why you get those divots in the cake mix next to the beaters? And, come to think of it, why does the cake batter always want to climb up the beaters? And why don’t all the bubbles coalesce during baking? (Baked a cake for Chris’s birthday tonight.)

ASSIGNED DISCUSSION “Record all valves you use for a twenty-four hour period. Include a description of the valves, what they were used for, what flow rates, what kind of valves they were, what conditions of service they see, what they are made of, special design features, or anything else relevant. Evaluate the selection of the particular valves for the particular applications. Give preferred alternatives, if any.” [...Valve list and discussion omitted from logbook example...]

students come to class prepared for lecture. This is not an unexpected result.

A class-related logbook is not a panacea for student learning or attitude. Its purpose is to help the student develop learning tools not specifically emphasized in other parts of the curriculum. For instance, assigning chapter outlines will not make the incorrigible student read the chapter, nor will it be the only reason the good student does a reading assignment. The main virtue of the outline assignment is that it shows the student a proven way of organizing challenging new material as a step to learning it. Whether or not this particular material challenges this particular student is irrelevant. When the student eventually does encounter challenging material, he should have various tools, such as outlining, in place so that the new content, not the concurrent development of the learning tools to master the material, will be the student's task at hand. The reasonable expectation here was not that all students would come to class prepared because logbooks were assigned, but that students who kept logbooks would improve their learning skills.

Another reasonable expectation for the instructor is that communication within the class will be greatly improved, especially if the instructor grades the journals encouragingly, as discussed below. The positive benefits of good student-instructor communication hardly need extolling here. The instructor will have great quantities of class-related information from the students for a surprisingly low investment of his time. In addition, that time can be scheduled at his convenience.

### ***Pitfall II: Inadequate Presentation of the Assignment***

To the students, the idea of "free-form" writing in a technical class sounds vague, confusing, and since it is a graded assignment, more than a little frightening. The instructor has three powerful tools to overcome student's discomfort: explanation, examples (modeling), and specific, focused mini-assignments. The handout in Table 1 demonstrates the use of each.

Collecting and commenting on the assignment frequently at the beginning of the term, as well as continued modeling throughout the first weeks of class, is a valuable use of time. As the students become more comfortable with the assignment, their anxiety will subside and the logbook will take very little class time the rest of the semester. The modeling in the initial part of the class usually is most successful if it draws on good examples from other students' logbooks, as well as from class projects (it takes about ten minutes to demonstrate how to outline a chapter from scratch). The mini-assignments are usually designed to integrate previously covered material and real-life experiences or to summarize and integrate recently studied material.

After a few summarization assignments, students often begin summarizing periodically on their own, an indication

that their writing tools are developing and becoming a habit. A particularly useful integrative summary is asking the students to predict what will be on an upcoming exam. Another is to ask them to design a flowchart for problem solving, based on their own problem-solving processes. Comparing their flowcharts from the beginning and the end of the term can be most instructive for both the students and the instructor.

### ***Pitfall III: Grading and Instructor Feedback***

Grading must reflect the process, not the product, especially early in the semester and in grading the journals. Some specific grading guidelines for the three parts of the logbook follow. In general, students should be allowed the freedom to make mistakes and should not be penalized for originality. Having said that, leaving mistakes uncorrected or not revisiting erroneous logic by the next time the logbook is reviewed is a legitimate reason for lowering grades. Some of the more specific detailed assignments may entail special grading criteria such as completeness and accuracy, which are mentioned at the time of the assignment.

Logbooks are graded on a ten-point scale each time they are collected, which is twice during the first three weeks of the term and then irregularly at two-to-four-week intervals thereafter. The journals are worth six to eight of the ten points. Chapter outlines and the reference pages are worth two points each early in the term, later decreasing to one point each.

Since chapter outlines and reference pages are good tools for studying and test taking, the students usually need little grade incentive to do well on those sections after the first test. The journals are more heavily rewarded by grades to encourage the students to develop the habit of making the intellectual efforts required to produce good journal entries.

The journal should be graded encouragingly, especially early in the semester. This assignment is strange to students, who are usually more accustomed to worrying about "what the professor wants" rather than how to acquire the lifelong learning skills the journal promotes. Since this journal is to encourage the habit of informal professional writing, it should be rewarding, not intimidating.

The actual value of the early grades for journals should be based on whether specific assignments are carried out and whether a good faith effort is being made to keep a journal according to the guidelines. As the semester progresses, expectations for the journal entries will be raised. Later in the term, grades may reward reasonable attempts for seeking answers, not just wondering about things. By the end of the term, the students should be able to attempt answering, at an appropriate level, most questions that they pose for themselves. These attempted answers should be reasonable, logical, and accurate, at a level appropriate to the students'.

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*Continued on page 231.*

## EFFECTIVE USE OF LOGBOOKS

*Continued from page 225.*

educational achievements. For example, specific assignments, such as summaries, can be graded more objectively and rigorously, for completeness and accuracy.

Instructor comments, rather than grades, are the real key to making the journal a valuable learning tool for enriching professional writing and organizational skills. Comments that praise curiosity, originality, insight, and innovative organization will increase students' efforts in journal writing. Comments that demonstrate the instructor's desire for open communication will make the journals more useful for the instructors. Also, instructors should address specific concerns raised in the journals, referring students to the text or other references rather than just answering questions. In this way, students will rely on their own initiative, rather than the instructor, in seeking answers to questions that have solutions within their capability to discover.

Copious instructor comments might seem to imply a huge investment in time, but experience has shown the opposite. Logbooks can be rapidly read. I often collect and read twenty journals (but not the reference pages or outlines) while proctoring fifty-minute class exams. The chapter outlines and reference pages generally need little correction after the first week or two of class, because the writing assignments are so concrete that engineering students have little trouble with them. (For a large class, these two sections might even be assigned to a teaching assistant for grading.) If term projects are required, the time spent on grading logbooks also pays a time dividend at the end of the term. Students produce better, more organized, and more easily graded projects when they have journal feedback throughout the semester on their writing and on their developing projects.

One technique that is useful in minimizing instructor effort while insuring copious useful instructor feedback is to write group remarks for common questions, problems, or insights. Instead of the instructor writing "Does this REALLY apply in the transition region?" in ten or twenty journals, he or she can distribute these written general remarks in class and the students can incorporate them into the individual journals. In addition to saving time, this method also helps the students realize they were not the only ones who had this particular insight or concern or error. This sort of realization bolsters student confidence in the rewards of journal writing and increases their enthusiasm. Journal entry quality seems to be directly correlated with confidence and enthusiasm.

The chapter outlines are the most objectively graded section. Format is generally up to the student, but it is evaluated for usefulness as a study tool. For example, the outlines must have proper page number annotation to serve as open-book tools. The outlines should be a page or two long, highlight-

ing and referencing the key concepts of the chapter. Long passages copied from the text receive lower grades, as they do not demonstrate the same ability to distinguish the main from the supporting, incidental, or supplemental ideas and facts. Content is graded rigorously on completeness and accuracy.

It is usually obvious from the content whether or not the students are really doing the intellectual work of reading and outlining, rather than just copying the table of contents or chapter headings. Such superficial efforts should not be rewarded with good grades. Again, modeling the concepts, by either composing the outline of the first chapter in class or by handing out examples of good student outlines early in the term will let the students know what is expected of them and improve their ability in outlining.

The reference pages are the student's personal study guides and need little grading. Instructor remarks can be limited to suggestions on possible omissions. Grades are generally quite liberal, but two behaviors should result in lowered grades for this section. The first is inaccuracies and errors that are pointed out by the instructor and are left uncorrected. The second is incorrect or inadequate referencing of sources, again, if left uncorrected.

### SUMMARY AND CONCLUSIONS

For the past few years, I have had positive experiences integrating writing and communication into undergraduate chemical engineering classes by means of logbooks, which include journals, chapter outlines, and reference pages. Although journals are a well-established pedagogical tool in many arenas, from music composition classes to English classes to teaching-methods workshops, there are definite challenges in using the device well in a technical course.

With proper structuring, the logbooks have been a positive communication and organizational tool for the students. They report that they like keeping the logbooks and find them useful as well. They feel that their opinions and concerns are being heard and they especially enjoy the tangible feeling of progress that looking over the journal and the summary assignments gives them. They learn and practice valuable writing skills not usually required and graded in the classroom.

The instructor also benefits from the logbooks, which provide an effective, convenient, and efficient manner of communicating with the students and monitoring and enhancing their learning experiences.

### REFERENCES

1. Bloom, B.S., ed., *Taxonomy of Educational Objectives: The Classification of Educational Goals: Handbook 1. Cognitive Domain*, David McKay Company, New York, NY (1959) □