Using Annotated Outlines to Enhance Learning

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Introduction

The course syllabus is an important feature of a well designed course, and some instructors even include a study guide as an essential part. While study guides are very useful to the student, they require a considerable amount of effort on the part of the instructor. Study guides can take several forms, including something as basic as a solution manual on one hand and a programmed text on the other. In between are supplemental lecture notes, case studies, tutorials, and collections of drill problems. In this paper, we present a demonstration on how the ordinary course outline can be expanded through annotation to become an effective, but abbreviated, study guide. In addition to the basic concept of the annotated outline, we will describe a framework that we use to help us organize the information into a cohesive structure that helps students assimilate the information for personal application.

An Overview of the Annotated Outline

Rather than developing a separate study guide, we chose to place learning related information in the course outline rather than in a supplemental study guide so that students will be more likely to use it. Since students should read the course outline to obtain the reading assignments and homework assignments, we felt that the outline would be the best place to write explanatory notes.

One of the primary features of our system is the way that information is labeled by type, which allows us to characterize information as we present it. From theories of individual differences and learning styles, we know that different individuals focus on different aspects and features of the information they receive. In extreme cases, individuals may completely ignore information of a particular characterization because he or she sees it as unimportant for learning or the information has gone by unnoticed. We have learned that classifying information by type and purpose has helped students identify important features, focus on essential information, and organize it in a useful structure.

What Learning Styles Tell Us About the Perception and Judgement of Information

We based our scheme of annotation on the learning styles model related to the Myers-Briggs Type Indicator (MBTI)[1-3] which is based on the works of Swiss psychologist Carl G. Jung's model of conscious human personality[4]. This model tells us that students differ in their perception styles and their judging styles, leading to differences in the ways that they select what they perceive to be important for learning. Some focus on procedures at the expense of general principles, concepts, and linkages, and vice versa. Some focus on the details, while others prefer to focus on a broad overview at the expense of procedures and strategies. Some have a preference for organizing their inner world, while others prefer to leave things in a flexible state. It tells that some pursue achievement through drill and practice while others prefer to pursue achievement through trial and error. Knowledge of these differences, coupled with classroom observations and years of individualized coaching have demonstrated that learning and test taking can be improved through improved learning strategies and processes and the need to help students make sense of the information presented to them in the classroom.

Disclosing the Expert's Learning Processes

When we witness a demonstration of expert human performance or a training session of such experts in physical activities such as sports, playing a musical instrument, wood carving, or sculpting, we are given a considerable amount of information the nature of expertise in those endeavors. While there are many invisible cognitive processes involved in such expertise, we are none the less able to come to some conclusions about the nature of learning and performance involved in these activities. When it comes to learning or taking exams, however, the observer has very little chance to observe the expert in his or her learning process and performance since the activity takes place in the mind. It is important that novice and intermediate learners be given clues into the mystery of expertise unless we are willing to take the attitude, "Either they have it, or they don't."

The process of experts is demonstrated in cooperative learning groups where experts demonstrate their processes during a work session. When the teacher lectures or demonstrates a problem solution or a derivation, he or she discloses some processes. However, without a structure whereby students can make sense of the learning processes, they may have difficulty assimilating them. By breaking down learning into processes that are classified by type, teacher and student can share a dialogue that can enhance learning.

Annotating the Outline

In our scheme, the ordinary course outline is augmented with different kinds of information that help the student accomplish learning. Notice that we say "different kinds of information"

rather than simply "information." In order to help students accomplish learning, we include information with two different characterizations: (1) subject related information and (2) meta-learning information.

Table 1 illustrates the structure of the annotated outline for two class periods. In the upper box, we added general **Notes**, a **Clarification**, a short tutorial on **Conventions**, and the ever demanded **Answers**. The lower box shows the addition of **Notes** and a **Strategy** which involves a **Technique**. Assignments for other periods might include **Hints, Procedures, Operational Definitions, Principles, Concepts, and Study Hints**. New categories are added as their need surfaces.

Subject Related Information

Subject related information needs little clarification. This refers to information that the instructor finds necessary to augment the normal course contents. This consists of the usual clarifications of ambiguous passages in the textbook, clarifications of the homework problems, hints on how to approach particularly difficult homework problems, numerical solutions, interpretations, extensions, essential information omitted from the textbook, and the like. This is especially useful for instructors who teach a course regularly and have come to know what additional materials students need to accomplish learning.

Table 1. An Example of the Annotated Outline

Read	Topic	Homework Assignment
1.4	Voltage and current	1.4a;5; 6; 7
1.5	Basic circuit elements and passive sign convention	

Notes: [1] Ignore problems 1.1, 2, 3, 4b, 8, 13b, 15, 19, 27. Problems to be ignored are those that are either not essential or too complex for the point they try to make.
Clarifications: [1] Drill problem 1.7 asks for "total charge." This means "over all time," from -• to •. [2] Be sure that you learn the process of inverting a derivative relationship to its integral relationship. [3] Be sure to learn that current flow has a numerical value **and** a direction of flow, just as the velocity of a moving object has speed and a direction. [4] For problem 1.5, "its maximum value" means "its first maximum value for positive time, including t=0."
Conventions: Throughout the course, you will encounter information in the form of conventions, such as the "Passive Sign Convention (PSC)." Failure to learn them will result in major sign errors, not like dropping a sign in algebraic computations.
Answers: 1.4a) 12.48×10^{13} e/s; 1.5) $q(t) = 4 \times 10^{-3}\sin(5000t)$ C; 1.6) 3.85 aJ (10^{-18}); 1.7) 156.04 µm/s.

4.9	Source transformations, successive source transformations	4.51a, 52a
4.10	Thevenin and Norton equivalents using $v_{o.c.}/i_{s.c}$.	4.54, 57a, 58

Notes: [1] Solve 4.54, 4.57a, and 4.58 using $v_{o.c.}$ and $i_{s.c.}$; then check your results using the test source method. [2] Practice solving them by other circuit techniques.
Strategies: "Successive source transformations" is a **technique** that can be used to solve many circuits that contain several sources. Source transformations can also be applied to dependent sources **provided** that the controlling variable is not lost during the transformation. Also be careful that the location of the output variable is not lost by the transformation.

Meta-Learning Information

Meta-learning related information, on the other hand, is intended to help students learn about learning. This is accomplished by defining a vocabulary and using it to heighten student awareness of the complexity of information and of the need to organize information for practical use. The complexity of information is emphasized by developing categories of information to make students aware that learning is not restricted to formulas, equations, and problem solutions as some believe. For example, we identify significant **procedures** to help students learn to recognize their significance and become able to identify them on their own. We highlight significant **operational definitions**, i.e., definitions that disclose an operation, to help students learn their value, and we highlight problem solving **strategies** to help students become accustomed to the idea that there may be more than one way to solve a problem. Table 2 gives a comprehensive list of the classes of

Table 2. Categories of Annotated Notes

Classification	Description	Purpose
Notes	Information of a general nature which does not fall into any other class	To inform without coaching in meta-learning.
Clarifications	Information that clarifies difficult concepts	Expand on information in the text book and lectures, particularly useful in cases which come up each time the course is taught.
Hints	Suggestions on ways to approach a problem	Serves as a tutor; helpful if used wisely by the student without becoming a crutch.
Answers	Answers to problems	Allows students to check answers but may make students dependent on answers.
Procedures	Step-by-step calculations that must be mastered	Informs students that there are important procedures that should not be reinvented
Operational definitions	Definitions that describe an operation	Informs students that operational definitions tell you what to do

Conventions	Sign conventions and modeling conventions	Informs students that signs do not simply "fall out of the math"
Strategies	Different approaches to solving a particular problem	Informs students that expert problem solvers have several strategies for solving a particular kind of problem.
Principles	Basic rules or laws	Informs students that there is more to learn than formulas, equations, solved problems and procedures
Concept	General ideas or understanding	Informs students of the need to see the "big picture" or overview.
Linkage	Link between two categories, such as between a strategy and a procedure or between an operational definition and a procedure	Informs students of the need to learn how different pieces of information relate to each other and to be able to find relationships that are not disclosed by the teacher or textbook author.
Study Hints	Coaching on how to study	Informs students that experts have developed a complex set of learning habits.

information that can be included in an annotated outline, and it also includes the purpose of the classification process.

Suggestions

Several semesters of experience with annotated outlines has helped us develop a list of suggestions that may help you develop annotated outlines for your students.

- Include information on how to read the annotated outline and its purpose. Let students know that careful use of the annotation will help them improve their learning.
- Avoid the temptation of duplicating too much of the lecture in the outline. It can be tempting to use the annotated outline as a hedge against omissions during the class period. Include only the most significant information that students might be ignore or miss or that you might forget to mention.
- Even if you do not include everything of importance, the annotation lets students in on the notion that information is complex and that they may need to look deeper into the material.

- Mention the annotated outline regularly in class until students become used to reading it. Students often fail to read beyond the homework problem assignment.

Student Reaction

Student reaction has been positive. Students say they were helped in solving the homework problems by using the hints. None said that they were distracted by the extra information in the outline. We expect, however, that at some threshold level, students will feel that the extra information has become more of a burden than an assistance, forcing them to read more than they want to.

Concluding Remarks

Experienced and talented learners have shown us for decades that they are able to accomplish learning without instruction in meta-learning and meta-cognition. However, conversations among faculty today suggest that either we are more aware of the need to help students persist and succeed in the classroom or that students actually need more help in accomplishing learning. The annotated outline is but one of the many tools that can be used to assist students in persisting by disclosing both the significant course related information and the significant processes of learning.

References

1. Felder, R.M. and Silverman, L.K., "Learning and Teaching Styles in Engineering Education," *Engineering Education*, April 1988, pp. 674-681.

2. Mc Caulley, M.H., Godleski, E.S., Yokomoto, C.F., Harrisberger, L., and Sloan, E.D., "Applications of Psychological Type in Engineering Education," *Engineering Education*, Vol. 23, No. 5, pp. 394-399.

3. Yokomoto, C.F. and Ware, R., "Improving Problem Solving Using the MBTI," *Proc. 1982 ASEE Annual Conference*, College Station, TX, June 1982.

4. Jung, C.G., *Psychological Types*, London: Ruthledge & Kegan Paul, 1923.

Biographies

Dr. Charles Yokomoto holds the rank of Professor of Electrical Engineering at IUPUI. He received the BSEE, MSEE, and PhD degrees from Purdue University. His current interests are in the area of learning styles, problem solving, and personal heuristics. He has been using the Myers-Briggs Type Indicator (MBTI) in research and classroom applications. In the field of electrical engineering, his research interests are in the area of computer-aided network design, optimization, and design centering.

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