An Algorithm For Incorporating Practice In And Around A Lecture

By Stephen Yelon

To improve the teaching of the basic sciences in a large university medical school, faculty agreed in principle to increase the use of instructional methods that involve students in the learning process. A curriculum committee was elected to insure that all improvement principles, including the active learning principle, were carried out by faculty. Curriculum committee members thought of active learning as practice to be provided during all instructional methods including the lecture. However, while basic science instructors understood how to increase the involvement of students in the learning process in clinics and in labs, they were not sure how to apply active learning to lecture. Even after a workshop about techniques to provide practice during a class, the basic science instructors were still reticent to incorporate active learning in their lectures. They argued that their class time was best spent dispensing the large quantities of information needed by medical students and that, if practice took place, it should be student generated practice done outside the class rather than instructor generated practice done in class.

Committee members were aware of the strong need for basic science to prepare medical students for their clinical work and for their medical board exams. The committee members felt, however, that students would not learn enough by merely listening to lectures and reviewing the information just before exams. They felt that with more frequent and systematic guided practice students would learn and retain more basic science. Furthermore, some committee members wanted to enforce active learning to change the common view that instructors are only dispensers of large amounts of information.

Is practice within a lecture good advice in this case and in similar cases? When is it most appropriate to implement practice in a lecture? To decide when and how to provide practice in and around a lecture, consider applying an algorithm based on effective and efficient practice principles.

Selected Principles For Effective And Efficient Practice

Instructors must provide effective practice. There are four principles of effective practice that we can apply to the problem of active learning in a lecture.

1. Active individual practice. Instructors must provide practice that calls for an active response from each student. Often, in class, only one or two students respond to an instructor's question. The outgoing students answer so quickly that other students do not even start to think about the question. In essence, only one or two students have the opportunity to practice. But instructors should give the opportunity to respond to each student. To assess understanding, instructors must ask questions or provide problems that allow each student the chance to respond in writing, aloud, or mentally.

2. Appropriate practice. Instructors must provide the opportunity to practice the same behavior under the same conditions as required on the test and the real performance. (Yelon & Berge, 1988) The task should be exactly the same in practice as on the test for recall tasks such as remembering the names for anatomy of the heart. But when the test requires application of concepts, principles or mental skills, practice should include new examples, new cases, or new problems. For psychomotor skill practice, the conditions should vary as they do in real situations.

3. Complete practice. Instructors must give each student the opportunity to practice on every type of test task. In their conclusion to a study on the effects of practice, Ellis and his coauthors (1980) state: "If the intent of the instruction is to have students remember important pieces of information (as in the present

study), then there should be a practice item and a test item for each piece of information. There should not be testing on information that will not be tested and there should not be practice on information that has not been practiced." They add: "If the intent of the educational program is to have learning transfer to new situations, then practice items would necessarily not be the same as test items, but both instructional material and the test should provide an opportunity to practice and perform such transfer."

4. Timely practice. In a recent review of literature on clear explanations, Chilcoat describes how an instructor should act during an instructional presentation: "The teacher should actively attempt to determine if students understand the information given to them. It would be counterproductive for a teacher to continue giving information or go on to another activity if students are unable to comprehend the information that has just been given." (Chilcoat, 1989) Thus, instructors must provide practice to determine whether or not students are ready to proceed to the next level of knowledge or skill.

Because time is a precious resource in training, however, instructors must also provide efficient practice. There are three principles of efficient practice that we can apply to the problem of active learning in a lecture.

1. Priority practice. If there is not enough time to test and provide practice for every task, instructors must make priorities among tasks. Instructors must provide practice for the most important tasks. As Ellis and his colleagues (1980) said: "If there are time and resource constraints so that all the important information cannot be tested, then the course material should be prioritized so that the most crucial information is practiced and tested."

2. Trading time for practice. If instructors are responsible for having students learn more content than they have time to explain, then instructors must make some tradeoffs. For example, instructors may provide practice outside of class instead of practice inside of class. If out of class practice is labeled "practice tests," students will participate. Another type of tradeoff might be an instructor, making up for time spent on practice in class by providing self-instructional materials to students. Thus, students become responsible for the relatively simple content that the instructor might ordinarily present. For example, Doig (1990) asked her medical technology students to fill in charts of basic facts, such as antibody characteristics of blood groups, outside of class instead of presenting that information in class. She states: "By using the textbook and structured study guides for teaching factual information, class time can be reserved for the more demanding learning of higher-level mental skills."

3. Feasible practice. Depending on performance requirements and conditions, some tasks cannot be performed inside a classroom. In those cases where a task cannot be performed in class, instructors might provide for practice in labs or work environments. Instructors, however, can assign many real tasks in the classroom which involve recall, recognition, prediction, inference, mental skill, and problem solving. Also, instructors can design classroom practice which prepares students for more realistic practice elsewhere.

In summary, there are seven rules embedded in the practice principles:

1. Provide practice that calls for an active response from each student.
2. Provide the opportunity to practice the same behavior under the same conditions as required on the test and the real performance.
3. Give each student the opportunity to practice on every type of test question, task, or problem.
4. Provide practice to assess whether students are ready to proceed to the next level of knowledge or skill.
5. Make priorities among tasks so that the most important tasks are practiced and tested.
6. To save class time for explanation or practice, provide practice outside of class, or provide self-instructional materials.
7. Provide practice in class when it is feasible; either provide whole practice of a realistic task or practice to prepare for a realistic task to be practiced elsewhere.

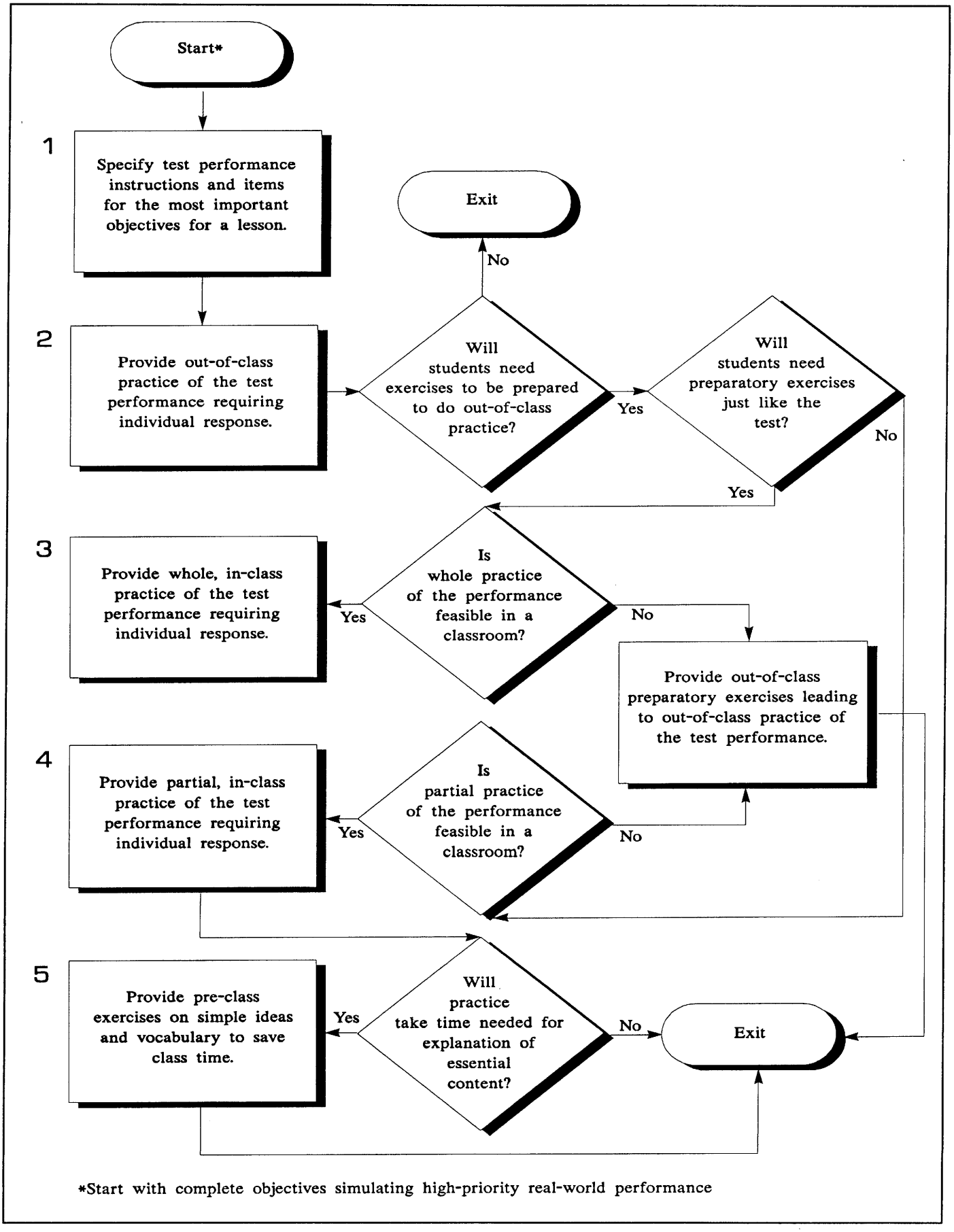
An Algorithm For Incorporating Practice In And Around A Lecture

As shown in Figure 1, I have applied the practice rules to create an aid to decide when and how to provide practice in and around a lecture. The algorithm was constructed to make decisions about providing practice in lessons. Certainly, an instructor can proceed through this process thinking about a whole unit or course. But it is easier to make careful decisions about smaller, more concrete segments of instruction such as lessons. Note that a lesson may include one lecture or several related lectures. So, for example, an instructor may make a decision about providing practice in one lecture, or a week-long series of lectures. The algorithm consists of five steps and five related decisions.

Step 1

To start, specify test performance instructions and test items for the most important objectives for

Figure 1. An Algorithm For Incorporating Active Appropriate Practice In A Lecture



a lesson. For example, suppose that I were teaching a course on motivation in which one lesson objective was: "For a given example of a motivational technique not presented in class or in exercises, students will be able to label or name the technique, according to the definition given in class." I might help students to achieve this objective in part by a series of five, one-hour lectures. Here are the test instructions and a sample item:

> *Test Items:* Below are some new examples and non-examples of motivational techniques. Put a check mark in the box beside each example of cognitive dissonance.
>
> ❑ 1. Manager says, "Good work. That's a fine report."
>
> ❑ 2. Manager smiles when workers come in on time.
>
> ❑ 3. Manager says, "Intelligent people think safety."

Step 2

To continue, provide out of class practice for test performance requiring individual response. Out of class means at home, in a lab, in an ongoing apprenticeship. For example, I might provide "practice test items" to be done at home such as those items on the test for recognizing motivational techniques. Note, however, that the examples are different than those provided in class or on the test:

> *Out-of-Class Practice Items:* Below are some new examples and nonexamples of motivational techniques. Put a check mark in the box beside each example of cognitive dissonance.
>
> ❑ 1. Supervisor gently persuades a worker who dislikes computers to try one.
>
> ❑ 2. Supervisor pays special attention to workers who suggest new ideas.
>
> ❑ 3. Supervisor creates a work team that considers problems and solutions.

I would tell students that a set of practice items which parallels the tasks on the test are available in their course materials. I may direct students to use the practice test at a certain time or leave the choice of when to use the materials to them.

Step 3

To proceed, provide whole, in-class practice of test performance requiring individual response,

- if students need exercises to be prepared to do the out-of-class practice,
- if the preparatory practice must be just like the test performance, or
- if whole practice of test performance is feasible in the classroom.

Predicting whether or not students need special preparation for out-of-class practice given only a lecture and text is the most critical decision in the algorithm. An instructor must ask if students must master some prerequisite knowledge or skill that will enable students to do the out-of-class practice of test performance. The accuracy of the prediction depends on the instructor's experience in teaching the subject. However, an instructor might anticipate the students' need for preparation based on the task's complexity and unfamiliarity.

For example, I might provide whole practice in class

- because I thought that students needed to be prepared to do the out-of-class practice tests on motivational techniques because of the difficulty of distinguishing among a dozen complex techniques.
- because I thought that students needed to practice in class so they could go through the entire mental process involved in making the comparisons of the attributes of each technique, and
- because I thought that I could easily provide items just like the practice test in class.

However, if I thought students needed no preparation other than listening to a lecture to do the out-of-class practice test, I would use only my out-of-class practice test. In addition, if I thought that preparatory practice was not feasible in the classroom, I would provide workbook exercises that lead to the practice of the test performance.

Here is an example of an item I would present in class just after I presented a few motivational techniques including cognitive dissonance techniques:

> *In-Class Whole Practice Items:* Below are some new examples and nonexamples of motivational techniques. Put a check mark in the box beside each example of cognitive dissonance.
>
> ❑ 1. Boss provides job aids for the more complex tasks in the office.
>
> ❑ 2. Boss states that fair-minded people treat others without prejudging.
>
> ❑ 3. Boss says she will give more flexibility for those people who produce.

I would project each practice item and ask the students to read it and answer silently. Then when all students indicated that they had answered, I would ask

the class for their choice and their reasons for their choice. If needed, I would remedy any misconceptions.

Step 4

If, however, students do not need practice just like the test performance, provide only the practice they need to be prepared to do out-of-class practice, if that is feasible in the classroom. For example, I might simply ask students for definitions of cognitive dissonance techniques, for some examples they may have encountered, and for a comparison of these techniques with other techniques studied. To give everyone a chance to respond, I would ask students to write their answers. Then I would ask for and post vocal responses.

In-Class Partial Practice Items:

"Write at least two ways to produce cognitive dissonance."

"Write another example of the use of cognitive dissonance that you have seen."

"Write the ways dissonance differs from meaningfulness and conceptual curiosity."

Step 5

If in-class practice takes time needed for the explanation of content, then provide a self-instructional assignment before a specific lecture on some relatively simple content from the lecture. You may use the time saved for additional practice or to explain more complex content. For example, I might assign a text reading and study guide questions as a pre-class activity. I might give a small amount of credit for doing the assignment, but I definitely would begin my presentation with only a very brief review of the pre-class activity and go directly to the partial practice items above.

Out-of-Class Pre-class Activity:

Read the chapter on motivational techniques and answer these questions.

"What are two ways to produce cognitive dissonance?"

"What are some examples of the use of cognivite dissonance that you have seen?"

"How do motivational techniques differ from each other? Fill in the chart below.

Conclusion

Is practice within a lecture good advice for teaching basic science to medical students? When it is most appropriate to implement practice in a lecture? Whether or not instructors provide practice in a lecture depends on their students' need for preparation for out-of-class practice, their students' need for in-class practice similar to out-of-class practice, and the feasibility of desirable practice in the classroom. However, even if an instructor does not provide practice in class, an instructor should at least provide individual practice of the test performance out of class.

Thus, this instructional algorithm is a compromise between situational constraints, and principles of learning. If instructors understand that solutions, such as active learning, depend on an amalgam of the contextual pressures and learning demands, they will be more accepting of the ideas and be more willing to use them. ■

References

Chilcoat, G.W. (1989). Instructional behaviors for clearer presentations in the classroom. *Instructional Science, 18,* 289-314.

Doig, K. (1990). Maximizing effectiveness of reading assignments. *Clinical Laboratory Science, 3,* 5, 310.

Ellis, J. Wulfeck, W., & Montague, W. (1980, Winter). The effect of adjunct and test questions similarity on study behavior and learning in a training course. *American Education Research Journal, 17,* 4, 449-457.

Yelon, S., & Berge, Z. (1988). The secret of instructional design. *Performance & Instruction, 27,* 1, 11-13.

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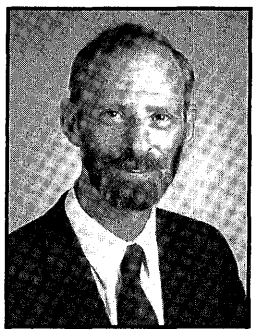

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