

**OPEN BOOK EXAMINATIONS:
A RESPONSE TO SOME RECURRENT CONCERNS**

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What kinds of subjects or courses are suitable for open book exams?

The suitability of open book exams depends not on the subject matter of a course, but on the kinds of questions we want students to answer, which in turn depends upon what is being tested in an exam. Ultimately, it boils down to what we want them to attain at the end of the course. If a course expects students to **memorize** the information given to them, and **reproduce** it in the exam, an open book examination is unsuitable. On the other hand, if a course expects students to be able to **process new information**, an open book examination is more appropriate. If a course aims to test understanding through exposition, open book examinations are not suitable; if it aims to test understanding through application to novel situations, then open book examinations are suitable.

Suppose we want to find out if students have understood the so called nature-nurture debate on the roles of genetic predisposition and environmental factors on human behaviour. We could design an exam question like:

"Critically evaluate the debate between nature and nurture in human behaviour."

This question is definitely not suitable for an open book exam, because, to answer this question, all that students have to do is copy either the material in the textbook or the prepared model answer they have brought to the examination hall.

In an open book exam we would ask a different kind of question. For instance, we could construct a question that tests the student's understanding of the debate on the basis of information that students have not come across in their textbooks or lectures. We might, for instance, begin the question by pointing out that children who are born blind still smile when they are happy. We would then ask students to discuss the nature-nurture controversy on the basis of this information. Does it provide evidence in support of one of the competing hypotheses? How can we formulate the argument? To answer this question successfully, students should be **familiar** with the nature-nurture controversy, and **understand** it in a deep sense. They should also be able to **think** carefully through the **new** evidence. They cannot answer the question by lifting material from the textbook or lecture, or reproducing ready made answers. The crucial concept here is that of processing new information in the context of what is already learnt.

If the ultimate aim of a course is **understanding** and **thinking**, then open book exams are very useful, but if the goal is **rote learning** and **regurgitation**, then closed book exams are clearly better.

How are open book exams different from closed book exams?

Intelligently designed closed book exams can be used to test thinking, but they are typically used as tests of memory. Open book exams cannot be used as plain tests of memory. If we want to ask questions like:

"Describe the Rutherford model of the atom."

"Give the structural formula for methane."

"Critically evaluate the biological account of aging."

we cannot use open book exams, because students can copy the answers from prepared answers. Such questions prompt students to regurgitate the information given to them in their lectures and readings. Flags like "critically evaluate" are only cosmetic, since what students are going to do is repeat the lecturer's critical views.

Students prepare for traditional exams by:

- (i) looking at previous question papers,
- (ii) spotting probable questions,
- (iii) constructing / finding model answers to these questions, and
- (iv) memorizing these answers.

Constructing a model answer on one's own deserves credit. However, given that model answers are easily available, usually from 'the seniors', all that students need to do by way preparing for the exam is to memorize such answers.

If students can spot the likely questions and come ready with prepared answers for an open book exam, the exam does not test even memory. Hence, open book examinations cannot allow questions whose answers students can prepare in anticipation. One consequence of this is that open book examinations cannot afford to **recycle questions**.

WHAT KINDS OF ABILITIES ARE TESTED IN AN OPEN BOOK EXAM?

What a closed book exam typically tests (in practice) is the ability to memorize and reproduce. An open book exam lends itself to a wide range of higher order abilities. Suppose we design a question that contains a two page passage on evidence of life in Mars, with a set of questions to test the students' ability to understand a piece of academic prose, understand the argumentation, evaluate the claim made by the author, consider alternative interpretations of the same facts, and so on. Such a question would be ideal for testing the **critical reading** ability. If the processing of the passage crucially requires the **knowledge content** of the course, the tasks can also test how well the students have mastered this content, and how well they can acquire new knowledge on the basis of what they already know.

Suppose we design a question that contains brief a case study of a company that is currently running at loss, with a set of questions to test the student's ability to analyze the probable causes of the problem, come up with a proposal to solve the problem, consider alternative proposals, and decide on the best solution. Such a question simultaneously tests the students' **understanding** of the concepts taught in a course, their **creative faculty**, and **decision making** abilities.

Undergraduate students in chemistry are generally told that the combination of atoms in a molecule may involve different kinds of bonds: single bonds, double bonds, triple bonds, and so on. An ethene molecule, for instance, is believed to have a double bond between the two carbon atoms it contains, while an acetylene molecule is believed to contain a triple bond. If an examination question requires students to write down the structural formulae of these two compounds, they can regurgitate the correct answer without a shred of understanding.

The first step towards building a generation of thinking students is to sensitize them to issues of evidence and alternatives. One of the reasons for assuming double bonds and triple bonds in ethene and acetylene is the valency theory. Hydrogen is assumed to have a valency of one, while carbon is assumed to have a valency of four. Ethene and acetylene have two carbon atoms each, so we would expect these molecules to have eight hydrogen atoms. Contrary to the expectation, there is evidence to believe that ethene has four hydrogen atoms, and acetylene has two. This puzzle is explained by the double bond and triple bond hypotheses. Suppose an examination question proposes that we explain the number of hydrogen atoms in ethene and acetylene by assuming that carbon has a variable valency of four, two and one. This variable valency hypothesis would allow each carbon

atom to combine two oxygen atoms (as in carbon dioxide), two hydrogen atoms (as in ethene) or a single hydrogen atom (as in acetylene). We can now ask students to choose between the two explanations in terms of available evidence. The answer to this question cannot be found in any of the standard textbooks. To answer this question, students will need not only a considerable knowledge of the facts of chemistry, but also the ability to think critically by pulling these facts together.

DOES KNOWLEDGE CONTENT GET IGNORED IN OPEN BOOK EXAMINATIONS?

Thinking does not take place in a vacuum. Solving problems, inventing explanations, evaluating alternatives, testing theories, and so on require close familiarity with and understanding of a large body of available facts, theories, analyses, and explanations. An open book examination can test the students' mastery of content indirectly by testing how well the student is able to apply this knowledge to new information. In fact, such application oriented questions are a superior means of testing the mastery of content.

Even memorization is tested through such applications, provided that what is memorized has a crucial role in the processing of new information. We do expect chemistry students to know that carbon has a valency of four, and physics students to know the equation that expresses Newton's law of gravitation. We do not treat such knowledge as meaningless memorization because without this knowledge further thinking in the subject will be impossible. What open book examinations will eliminate is rote memorization with the goal of simply reproducing what is memorized, not memorization that enhances the efficiency and speed of thinking in a given domain.

HOW DO OPEN BOOK EXAMINATIONS AFFECT THE PROCESS OF LEARNING?

The traditional learning strategy of spotting, preparing and memorizing answers will not work for open book exams. What students will have to do, instead, is to practise **activities** that lead to the development of the **abilities** that open book exams test. If we have to take a test in swimming or piano playing, we don't try to memorize a set of ready made answers. Rather, we engage ourselves in activities that enhance our ability to swim or play the piano. The same holds for open book exams as well.

Students who are used to traditional examinations take a long time to figure out how to study for an open book exam. It is therefore necessary to help the students change their study habits by giving them quizzes and mock examinations. One of the speakers remarked that in his courses, more than fifty percent of the students simply flunk in the first open book quiz, because they come in with memorized answers without any practice in thinking that calls for processing novel information in terms of what they have learnt. The postmortem of the quizzes helps students see why they did badly, how they can study to do better, and so on. By the time they come to the third quiz, most students have a reasonable idea of what open book examinations call for. They stop looking for ready-made answers to questions. After the third quiz, they are ready for the final examination.

HOW WILL OPEN BOOK EXAMINATIONS AFFECT THE PROCESS OF TEACHING?

If we are going to use open book examinations, it may be necessary to replace the lecture mode of teaching with an interactive mode. In a traditional lecture in a university, the lecturer delivers a fifty minute lecture, and the students listen **passively** and **take down notes**. In the student's mind, each lecture gets converted into a **possible answer for a potential examination question**. They write down the **points** made by the lecturer on each

topic, including the lecturer's criticisms, and **reproduce** the points in the final examination. The lecture method is ideally suited for **regurgitation** in closed book exams.

In an open book examination, the focus shifts from the **reproduction** of information to the **processing** of information. What this means is that the focus shifts to the testing of certain abilities closely tied up with the knowledge content presented in the course: the ability to apply a theory, test a theory, propose an explanation, interpret the meaning, infer predictions, design an experiment, find logical inconsistencies, and so on. We cannot help students develop these abilities by lecturing to them. The crucial concept here is **active interaction**: students actively interact with the teacher, instead of listening passively to the teacher.

One may think of a teacher as a **master craftsman**, and students are **apprentices**. One of the speakers said that he thought of himself as an experienced potter. His classroom is not a lecture hall, but a pottery workshop. Students make clay objects in the workshop, individually and collectively, and receive feedback both from the teacher and from other students. The basic idea is that students **construct** and **critically evaluate** a large part of the knowledge that we expect them to acquire in a course. By doing this, they develop their creative and critical faculties while acquiring a body of knowledge, and are able to extend the knowledge beyond the classroom and examinations. The teacher, like a master craftsman, helps them construct and evaluate the knowledge.

In the lecture method, the teacher is at the centre of the picture. In the interactive workshop method, the focus shifts from **what the teacher does** to **what students do** in the classroom. If we use open book exams, the lecture method must be replaced by the workshop method, or some other student centred interactive method of triggering learning in students.

Needless to say, not all lectures are necessarily geared towards regurgitation. In a graduate course in MIT, Caltec, or Stanford, we do find some of the top people in the field communicating their recent ideas to students in the form of lectures. But these are contexts in which students are already well trained in their thinking abilities, and are not afraid of challenging the lecturer and converting the lecture into a discussion. In a context where students are not trained in the active mode of learning, however, the lecture mode is perhaps not the best.

To conclude, open book exams trigger a transformation of the modes of teaching and learning which enhances the students' creative, critical, and decision making faculties. The overall result can be summed up in two words: **enhanced intelligence**.