Teaching Logic as a Foreign Language On-Line

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There are many problems facing students and teachers of logic and there are many possible solutions. Here I want to call attention to one kind of problem and one possible solution to it. I will suggest that our practice-based methods of teaching logic need to be developed a little further to aid students in learning particularly difficult sections as well as to aid those students who find logic to be especially hard. Such developments are made more realistic due to the new technological developments, especially in the on-line teaching environments.

The Problem and the Analogy

The problem is in many ways parallel to the type of problem one has in learning and teaching a foreign language. While modern pedagogy of foreign languages has devoted much of its attention to conversational skills of the student, there still exists a very mundane and difficult area of grammar learning. It is exactly this area that is in many ways very similar to logic learning and teaching. The new grammatical structures one must learn are frequently at odds with one's native grammatical structures (sometimes radically—think about the German verbs being placed at the end of dependent clauses, for example). As a result, they have a way of sliding off one's mind: one makes mistakes and notoriously slides back into one's native structures. The only way to aid the problem is through "mindless" repetition of the new structures. One textbook based on this idea proposes exercises with choices of various grammatically equivalent phrases that need to be repeated aloud in various combinations with other grammatically equivalent phrases. For example, a choice of eight noun phrases coupled with some constant sentence structure and a choice of six verb-phrases would combinatorially yield forty-eight sentences that had to be read out loud. The process takes "forever" but it usually eventually succeeds in instilling the relevant structures.

 0145-5788 pp. 117–125

One of the important problems many students have in learning logic has a similar origin. The structures they need to learn are just too foreign to them. This is intensified by the symbolophobia that many students fall prey to by the time they begin the study of logic. In many ways, the traditional approach to teaching logic, where teachers require of students that they complete all or most of the exercises in the textbook, is a step in the right direction. It has two important limitations. First, there are students for whom the standard exercises are already too hard. Although most good textbooks have exercises with an increasing degree of difficulty, there are students who would require an even more gradual approach. Second, there are topics in teaching basic logic (up to first-order quantificational logic) that prove persistently difficult even to the better students, *e.g.*, the idea of substitution instances, the proof techniques, etc. In both cases, the standard exercises do help but they are not quite as effective as one might wish them to be.

Repetitive Exercises

It is here, I conjecture, that the analogy with teaching complicated grammar structures of a foreign language might be fruitful. I suggested above that the standard exercises are just not sufficient for some students and/or for some topics. They seem to go too quickly. Before students have a chance to really develop a certain skill of, say, symbolization or recognizing substitution instances in simple cases, they are already expected to apply the skill to more complex cases. Confusion ensues.

One way to help here is to offer the students an additional set of exercises—let us dub them "repetitive exercises"—that would enable them to develop the required skill through repeated application of a concept or operation on simple cases. Two examples of such exercises follow.

Example 1. Not-Both and Neither-Nor

In a logic course I teach on-line, I have been faced with an epidemic of students who notoriously confuse the symbolization of "not both p and q" with that of "neither p nor q." I have been trying various traditional ways of explaining the difference on intuitive examples as well as concrete suggestions on how to use mnemonics. They helped a little but the results were far from satisfactory. Finally, I developed a set of new "Neither-nor/Not-both" exercises, where the students had to symbolize various English sentences into one or the other of the structures. Unlike regular exercises that vary the complexity of the sentences, most of the sentences to be symbolized in this exercise were

very simple. This is because its point was mainly to let the students apply the symbolization structures to enough cases to help them in developing and settling on a neither-nor and a not-both mind-set. Only after they have done so would it be at all fruitful for them to go on to try the regular exercises where they would be required to apply the acquired skills in cases of an increasing difficulty.

Example 2. The Main Connective

The idea of the main connective is difficult for many students but the problems are notorious when students must distinguish the negation of a conjunction, say, from a conjunction whose first conjunct is a negation. It seems that the problem many students have is not quite intellectual; rather it is as if the difference were somehow slipping their mind. They do one case right, then fail the next.

The regular exercises on the main connective will usually begin with simple statements and gradually increase the degree of complexity—both with respect to increasing the degree of complexity of the statement itself as well as with respect to including negation (see Fig. 1). Such exercises involve enough variation among the placement of the negation to grasp the ways in which negations matter in deciding what the main connective is. They are, however, frequently not sufficient to develop the concept of the main connective. Some students fail to grasp it and as a result have problems with truth-value calculations. In such situations, it might be beneficial to offer repetitive exercises.

Test Exercise	Repetitive Exercise
$A \vee \sim B$	$A \vee \sim B$
$\sim A \vee B$	$\sim K \vee L$
$\sim(A \vee B)$	$\sim(M \vee B)$
$(\sim A \vee B) \& C$	$\sim A \vee B$
$(\sim A \& \sim B) \vee C$	$\sim(A \vee B)$
$A \supset (\sim A \equiv \sim B)$	$\sim A \& C$
$\sim B \vee (A \supset C)$	$\sim C \& \sim D$
$\sim[C \equiv (\sim A \& B)]$	$A \supset \sim C$
$(\sim A \& \sim B) \vee (C \supset \sim B)$	$\sim(A \supset L)$
$\sim[(\sim A \& \sim B) \vee (A \& B)]$	$\sim(\sim B \equiv C)$

Fig. 1. A fragment of a test exercise and a repetitive exercise to test/train the idea of the main connective.

A repetitive exercise simply presents the same types of cases in various combinations of sentence letters and connectives. Student should do them until they grasp the idea. This might involve sitting down to do it at various time intervals as well as going through the exercise with an instructor's guidance in case there are problems. After successfully completing the repetitive exercises, they can try to complete

the test exercises. Hopefully, the student will have by then developed an "eye" (or a schema) for the main connective.

Repetitive and Test Exercises

It is important to emphasize the contrast between repetitive exercises and regular exercises. Regular exercises are designed first and foremost to *test* whether the student has grasped the concept and/or developed a certain skill. Repetitive exercises, on the other hand, are designed to *help* the student grasp the concept and/or develop the skill. Unlike in the regular exercises, the correct answer in the repetitive exercises is obvious and may already be implicit in the very setup of the exercise (*e.g.*, the student might know that the exercise consists in applying either a not-both or a neither-nor symbolization structure). The degree of complexity of the cases does not vary much, if at all. They are much more simple, to the point of seeming hopelessly repetitive and boring to someone who already knows or has no trouble with the material. But they may be just what the doctor ordered to someone who finds the regular exercises too difficult.

Clearly, repetitive exercises should not replace regular exercises but rather supplement them. Moreover, it would be ideal to treat them as remedial exercises, not as required from everyone; otherwise one would risk torturing those students who have grasped the material.

One of the important advantages of repetitive exercises is that they also give the students a distinct sense of satisfaction. If a student is lost because things just go too quickly, these exercises do give them a sense of "I can do it"—much in the way that such repetitive activities give such satisfaction to children, who learn new skills in just this way.

Two Problems

I should point out that there are at least a couple of problems with repetitive exercises. First, students might want to skip them unless the instructor actually requires and grades them. Second, there is a danger that students, rather than developing the appropriate schema, will simply memorize the answers, in which case they will not be able to apply the schema successfully to more complex cases but will be lost when confronted with them.

A Practical Problem and an On-Line Solution

I have only anecdotal evidence that repetitive exercises really do help some students with logic, but let us simply assume that they do. Let us assume further that the logic teacher has enough time and motivation to construct myriads of repetitive exercises to help her students.

The students will now sit down and laboriously do the additional exercises. Or, they will find them a waste of time, try a few, and then try their hands again at the test exercises. In the traditional classroom setting, the conscientious teacher has a choice—either leave the matter to the student's responsibility or require that the student hand in the exercises, which will then be added to the pile of tests she or her assistant have to grade.

The on-line learning environments (such as WebCT or Blackboard) provide help here. The instructor can administer the repetitive exercises on-line, where they will be graded by the computer. This gives the instructor more room to assign repetitive exercises as well as more control over whether and how the students actually prepare themselves.

One can further enhance the educational value of the exercise by giving the student "pre-recorded" feedback in case the student chooses the wrong answer. One can vary the feedback for each answer thereby allowing one to identify and to comment on the kind of mistake that the student has committed.

In addition, the cost of preparing the repetitive exercises is not so great. In WebCT, it is possible to import text files with questions that have been prepared according to a specified format. So one can use any word processor and apply search-replace functions to copies of a prepared template, thereby quickly generating myriads of new questions.

Memorization vs. Developing a Schema

The second problem touches on the very viability of such exercises and deserves a comment here. There are in fact two issues that should be separated. First, the student might develop a schema for recognizing the relatively simple cases but be helpless when confronted with the more complex cases given in the test exercises. Second, the student might just fail to develop a schema even for the simple cases but merely memorize the answers.

The second issue can be addressed in a platform such as WebCT, which provides the option of generating a quiz or an exercise with questions chosen randomly from a group of questions. As a result, the same exercise can be administered many times, and each time the questions the student answers will be somewhat different. In this way, the student might successfully take repetitive exercises more than once without the danger of the questions repeating themselves all the time.[1] Of course, there might be some repetitions but there will not be as many as to render the repeated taking of the exercise an exercise in sheer memorization.[2]

It is less clear that any technological feature could address the first issue, *viz.*, that the students' skills cover only the simplest answers

but when confronted with more complex ones, they will be helpless. Such students might reliably distinguish the negation of a conjunction from a conjunction whose first conjunct is a negation, but fail when the conjunctions are themselves complex, for example. Here the only solution is the traditional one of easing the student slowly into the quagmire of complexity. My favorite path to the idea of the main connective has three stages: complex conjunctions/disjunctions, negation and simple conjunctions/disjunctions, negation and complex conjunctions/disjunctions. And it can also be supplemented by appropriate repetitive exercises that target a given order of complexity. So a repetitive exercise at the first stage might involve first-order nesting of conjunctions/disjunctions (at most single, no double parentheses). Another repetitive exercise might involve second-order nesting of conjunctions/disjunctions (at most double, but no triple parentheses). And so on.

BORE and the On-Line Teaching Community

I have been advertising here a rather simple idea that can be potentially quite powerful in helping students with acquiring logical skills. I have been also advertising the use of such platforms as WebCT to administer repetitive exercises. However, the idea is not somehow intrinsically wedded to the on-line learning environments and could also be potentially embodied in the form of special exercises added to textbooks on a CD. I do believe, however, that there are good reasons to prefer the home-made on-line solution to the commercial product.

First, the commercial product is only a potentiality while the home-made solution is within the reach of every logic teacher provided that his institution makes use of the on-line teaching platforms.

Second, what repetitive exercises will be needed will depend on particular students' needs. While there are easily identifiable areas where many students have problems, for which one could offer pre-made repetitive exercises, there are others where this will not be as viable. As a result, it is more than likely that there will be exercises that may be needed by a student and that will not be included in the ready-made package.

Third, one could envisage a *Bank for On-line Repetitive Exercises* (BORE)—a website that assembles the text files ready to import to WebCT containing the questions of repetitive exercises on a given topic. In this way, the logic teachers could consolidate their efforts in preparing repetitive exercises. They could share as well as improve their work, thereby creating an on-line teaching community.

Last, but certainly not least, the on-line teaching environments are full-blooded teaching platforms—the exercises are submitted in the

space that is accessible to the teacher. As a result, the teacher has a way of checking the students' progress and work, and can comment on the exercises the student is submitting immediately after they are submitted. This enhances communication and also conveys to the student a sense of accountability.

Since I have been opting for the on-line solution, I would like to close with two comments, one concerning the choice of platforms, the other concerning what (still) constitutes an important drawback of using the on-line solution.

WebCT or Blackboard?

Of the two major on-line teaching platforms, WebCT and Blackboard, WebCT is richer in its testing capabilities than Blackboard, though the recently released Blackboard 6.0 has tried to rework its assessment engine so as to measure up to the possibilities offered by WebCT. While Blackboard is simpler and more user-friendly, it still does not offer as many testing options as does WebCT. I have already mentioned the crucial option of randomly[3] choosing questions from a list of questions on a particular quiz. I provide a short table as a brief comparison of the systems in their testing capacity.

	WebCT 3.6	WebCT 3.8	Blackboard 5.5	Blackboard 6.0
Variety of questions (multiple-choice, fill-in, matching, etc.)	●	●	●	●
Variety of options for creating questions, especially:	●	●	◖	◖
—feedback for each answer	●	●	◖*	●
—possibility of assigning different point value for each answer	●	●	○	●
—random order of answers (for multiple-choice questions)	○	●	○	○
Random choice of questions from a group of questions in a quiz	●	●	○	○
Random order of groups of questions in a quiz	○	○	○	○
Possibility of creating questions in a .txt file and importing them	●	●	○	●

Table 1. Comparison of the on-line testing capacities of WebCT and Blackboard
● available; ◖ partially available; ○ unavailable
*Earlier versions of Blackboard provide the option for giving feedback for correct and for incorrect answers.

One Important Drawback of the On-Line Solution

An important drawback of using the on-line systems for teaching logic in particular is the poor support they give for the use of special symbols. While it is possible to use special symbols in the on-line lectures (HTML), it becomes either impossible or unrealistic to use them in other areas of the course. In WebCT, it is impossible for students to enter special symbols when entering text on-line—only ASCII characters are supported. Yet this is a crucial form of testing the students' logical skills—one cannot just rely on multiple-choice answers. Moreover, while it is possible to prepare multiple-choice quizzes or post discussion messages in html using appropriate codes for the special characters, it is unrealistic to do so. Not only would one be presented with a non-perspicuous jungle of what appear to be meaningless symbols, one's ability to double-check that one has not made a typo, for instance, is seriously diminished. Of course, one *could* use the Preview function but it is unreasonable to expect anyone to do so on a large scale.

The weight of this problem is diminished in a course that is taught entirely on-line. I simply ask my students to transliterate logical connectives into the graphically closest ASCII symbols; we use ">" for the horseshoe, "v" for the wedge, and so on. Since much of the work they do is done on-line, they simply get used to an alternative way of writing the symbols, though I emphasize that they should work out the textbook exercises on paper first. In a course that merely supplements the teaching of logic with on-line exercises or quizzes, this becomes an even more problematic issue. The students who would require repetitive exercises are only likely to be more confused by the symbol changes.

One can only hope that with the new releases of the on-line teaching platforms, the use of special symbols will cease to be a torture.

Conclusion

I have suggested that one of the problems that students have in learning logic may be due to the fact that the conceptual structures that they need to develop require more time (and more exercise) to settle in. This kind of problem is parallel to a problem we experience when learning foreign grammatical structures, where we inadvertently slide back to our native ways of speaking. The best solution is to practice and, by analogy, this is the best solution in helping students who experience difficulty in grasping logic.

I have further suggested that the standard exercises that we ask the students to do might be too difficult for students who are already having problems. The best solution in such cases will be to assign

the students not just more exercises but a special kind of exercises, viz. repetitive exercises. The main goal of these exercises is to allow the students to develop and/or crystallize the appropriate conceptual schemata by repeated solution of different but relatively simple problem cases. They should take the regular exercises only after they have mastered the repetitive exercises, *i.e.*, only after the repetitive exercises seem *repetitive to them.*

Finally, I have argued that one of the best, though still imperfect, media for doing so are the on-line teaching environments, which are flexible enough so that the teacher can develop the questions he deems appropriate, and yet automatic enough so that he does not need to physically grade the numerous submissions.

Notes

Most of the ideas presented here have developed as a result of my teaching Introduction to Logic (fully on-line) at the University of Southern Mississippi, which I have been offering regularly since summer 2002. I would like to thank the Department of Philosophy and Religion at USM for their support and encouragement. I would like to thank especially Sam Bruton, Ronald Burt, David Holley, and Forrest Wood.

1. The same feature is very helpful in securing the integrity of test taking.

2. The latest version of WebCT, 3.8, adds the option of randomly generating the order of answers in multiple-choice questions, thereby adding yet another dimension to the "freshness" of the quizzes and exercises.

3. A note of caution here. From my experience with WebCT, the randomization feature does not always work very well. I have occasionally seen repetitions of questions on quizzes that were just a little too frequent to really seem to be random.

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