Using Simple Animated Presentations (SAPs) in Teaching Elementary Logic

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Many of the problems that students have in grasping logic occur at the very basic levels: of seeing patterns, of applying derivation rules. While classical chalk-and-board and word-of-mouth methods for presenting the material must not be replaced, it might be helpful if they were supplemented by more animated ways of presenting the material. This paper describes some existing and some not yet existing SAPs (simple animated presentations) that may be helpful in teaching Introduction to Logic courses.

The paper is somewhat of a mishap for at least two reasons. First, it is hard to use exclusively the word-to-eye method to discuss animated presentations. (Some snapshot illustrations are included in the paper.) Second, the work that the paper reports is still in progress. In fact, it would be safe to say that none of the presentations mentioned are *really* finished, and many of them still do not exist even in outlines. The last point, in particular, shapes much of the purpose of the paper. Insofar as the idea of SAPs is both worthwhile and manageable, it would work best as a collective rather than individual enterprise (see final section). The paper is as much a presentation as it is a call for assistance.

The discussion splits into four sections. First, some existing as well as non-existing SAPs are described in the first secition. The second section explains and speculates on why SAPs ought to be conceived as short and simple rather than long and complex presentations. In the third section, some technical limitations of using SAPs are noted. The final section discusses some prospects for the use and development of SAPs.

Before proceeding, it ought to be noted that all the SAPs I have actually developed were meant to accompany Virginia Klenk's *Understanding Symbolic Logic* (Englewood Cliffs, N.J.: Prentice Hall). All of them were written in Microsoft PowerPoint.

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Simple Animated Presentations (SAPs)

There is a lot about the educational process we do not understand very well. Among such not well understood phenomena is the sort of effect that the form, in which the material is presented, has on the efficacy of teaching. Teachers usually know from their own experiences as both teachers and students that certain ways of presenting the material, which might include various pictorial and graphical representations or certain metaphors used in conveying the ideas, appeal to students more than others. It is as if certain ways of presenting the material have the capacity to attach themselves to the students' conceptual structures in ways in which others do not. The suggestion that simple animated presentations (SAPs) be used in teaching logic is grounded in a hope that the use of animation will not only enliven logic classes but also help the formal material sink into students' conceptual structures better.

The idea for using animated presentation in teaching is at least as old as educational television. But it is only now, with the development of faster computers, with better graphical capacities, and appropriate accessible software, that the use of animation becomes a reality for an ordinary teacher. In this section, I describe in some detail various existing as well as non-existing SAPs that may be used to enhance the presentation of elementary logic.

A SAP is a *S*hort *A*nimated *P*resentation that uses some representational metaphors (implemented by the use of animation and color) to capture logical concepts and techniques. (The meaning of this characterization ought to become clearer in the discussion of some examples.) SAPs can be used at all stages in an introductory course. They can enhance the students' understanding of symbolization techniques, of the truth-table method, and finally, and perhaps most fruitfully, of the proof method.

Before proceeding, one point should be stressed (it will be elaborated in section 2). One should resist the temptation to *replace* the mentioned classical methods of conveying the material with the high-tech ones. Accordingly, the presentations ought to be brief and to the point, focusing on but one particular issue. All of the SAPs actually discussed fit this format.

There is no significant order of the following discussion, except that I begin with the area where I believe SAPs can prove most useful—in teaching the proof method.

The Progress of a Proof. SAPs may be useful in illustrating the progress of a proof. Frequently, there are students who do not follow the progress of a proof on the board as quickly as do others. Even if they are able to apply the rules correctly, they get lost in trying to see which lines in the proof are actually used in obtaining the formula.

In a SAP, at any step of the proof, the irrelevant information may be shadowed out and appropriate colors may be used to emphasize exactly what (and in what way, see the discussion of inference and replacement rule SAPs, below) is involved in making a particular step in the proof.

The Difference between Inference and Replacement Rules. Klenk introduces both inference and replacement rules. Moreover, the system without replacement rules is not complete. This gives rise to the additional burden that the students have to (rather than having an option to) learn/memorize ten additional rules within a rather short time-span. (And the proofs using only inference rules get boring rather quickly.) One disadvantage of this is that replacement rules are in general harder to apply and, moreover, the differences between them and inference rules tend to be confusing for students.

The presentations that introduce inference and replacement rules accordingly try to emphasize the differences between these two types of rules by using two different overarching metaphors for them. While the overarching metaphor for inference rules is that of a process of *creation* where some formulas (the premises) give rise to yet another formula (the conclusion), the overarching metaphor for replacement rules is that of one formula undergoing a *transformation*. In the case of inference rules, a new formula is created. For example, if the application of inference rules requires two formulas (as does Modus Ponens, for example), this means that a third formula will be added to the screen where the other two formulas still reside. In the case of replacement rules, since the metaphor is that of one formula being transformed into another, the original formula is no longer in view during the animation since it is being transformed; only one formula is visible on the screen. A proof in the latter case is a way of keeping track of transformations that a single formula undergoes.

Inference Rules. An inference rule allows one to infer the conclusion from the premises. What a SAP can emphasize is the pattern involved in such a transition. Ordinarily, a SAP will introduce a representational metaphor that is distinctive of an inference rule in question, and implement it using color and animation. The Modus Ponens SAP can serve as an example (Figure 1).

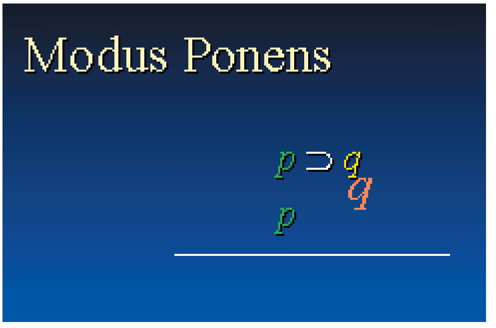


Figure 1. The Modus Ponens SAP.

Two colors are used. The formula in the antecedent is green; the formula in the consequent is yellow. The representational metaphor is the obvious one of separating the consequent once the antecedent is locked in by the antecedent-formula appearing on a separate line. The use of colors helps in keeping track of the structural affinities of the formulas involved and is also essential in applying Modus Ponens to more complex formulas. The animation, in turn, makes the idea of inference more vivid—a copy of the consequent-formula flies over to the conclusion.

The described SAP may help in one common confusion arising in the application of Modus Ponens. It is notorious that some students tend to disregard the significance of the inference line between the premises and the conclusion in applying inference rules. Such a student will mention Modus Ponens to justify inferring A (and on a separate line B) from $A \supset B$. The SAP described may aid here in two respects. First, the inference line is drawn only when (a) the antecedent-formula appears separately on a line and (b) it is "locked in" with the actual antecedent (by a box surrounding both which appears on the screen for a moment). Second, the actual application of the rule is marked by the *process* of the consequent-formula *flying over* to the conclusion.

Replacement Rules. Replacement rules differ from inference rules in two ways. First, replacement rules can be applied in two directions. Second, replacement rules can be applied also to subformulas. The presentations capture these two peculiarities of the replacement rules in two ways. The first feature is captured by the use of a different overarching metaphor for their presentation. As mentioned above, while the overarching metaphor for inference rules is that of a process of creating a new formula from pre-existing formulas, the overarching metaphor for replacement rules is that of a transformation of one formula into another. The second feature of replacement rules is captured by the employment of a zoom-in box. The box highlights the part of the formula where the application takes place (Figure 2).

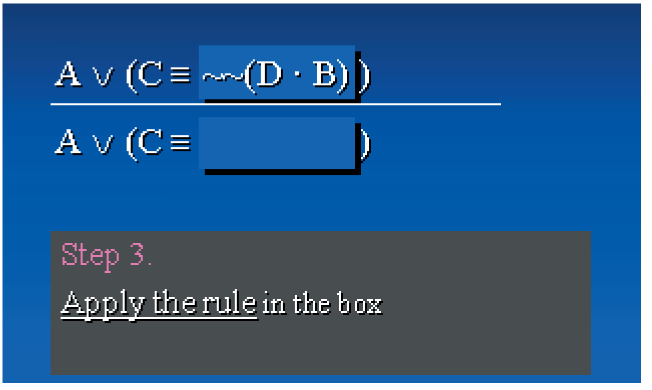


Figure 2. Application of a replacement rule to a subformula.

As do inference rule SAPs, so replacement rule SAPs try to catch onto a graphical metaphor that the student could think to be distinctive of the transformation in question and recognize later in proofs. The Double Negation SAP, for example, illustrates the application of DN in one direction (to a formula with two tildes) with a pointed finger appearing on the screen to shake the two tildes loose, as a result of which they drop down and disappear from the screen (Figure 3). The application of DN in the opposite direction is marked by a fairy-tale sparkling star appearing on the screen and leaving behind two tildes, which then drop to the appropriate place in the formula (previously illuminated by a box). The De Morgan SAP uses the metaphor of the initial tilde spreading over the elements in the parenthesis: the tilde travels up and over the parenthesis; when it is over the major connective of the parenthesis it splits into three tildes; the middle one drops slowly at the same time as the dot or the wedge moves upward; when they clash, they become transformed into the wedge or the dot, respectively, which then drops into place; thereupon the two other tildes drop in their respective places. (I mention some options for a SAP to illustrate the application of De Morgan in the other direction in section 4.)

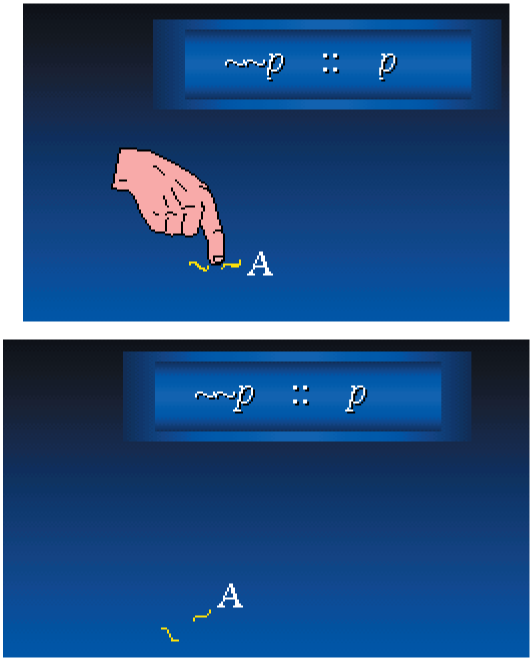


Figure 3. The Double Negation SAP

The Idea of a Variable. While the idea of a variable is already well-entrenched in the conceptual structures of some students, for others variables seem dangerously close to constants. One way of emphasizing both the distinctness and the relation between the two is to employ the metaphor of a variable as an exploding box. Individual constants then "jump" into the variable boxes. The boxes may be marked by different colors to mark different variables in a formula.

The Logical Structure of Formulas. A SAP can enhance the students' grasp of the idea of the logical structure of a formula. The SAP on The Logical Structure of Formulas begins first with what the students can do in their notebooks—the step-by-step pairing of parentheses thus arriving at the logical structure of a formula. The connectives are then numbered reflecting the order of the construction of the formula. Thereupon, the subformulas (in the order of their connectives) drop a little thus revealing the structure of the formula. What the animation adds over and above what can be represented in the textbook is the fact that the student can witness the process of such deconstruction.

The Base of a Truth-Table. A simple SAP illustrates the implementation of two algorithms for constructing truth tables. The use of animation and color (different for Ts and different for Fs) helps to make the process more vivid and clear than is usually possible using the blackboard.

The Calculation of Truth-Values in a Truth-Table. SAPs can help in teaching the truth-table method in at least two ways. First, they can help to illustrate the calculation of truth-values in truth tables. In particular, the order in which the truth table is filled out can be emphasized by use of shading and color. The truth-values that are no longer used are shaded; those that are used are appropriately colored. Second, the determination of the logical properties of sentences, arguments, etc. can be illustrated vividly with color.

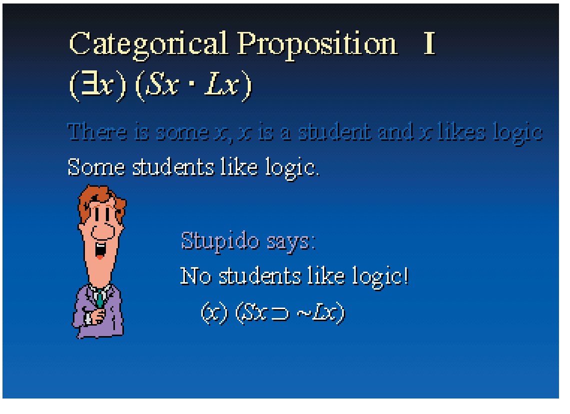
Symbolization. SAPs may also be used to supplement the teaching of symbolization.. This is primarily because they allow the students to see the progress of symbolization virtually step by step—something that the students never see on the blackboard. Moreover, the possibility of using color to mark different simple sentences employed may be particularly helpful when the schematization requires that the order of sentences be changed.

Other Uses: Visual Demonstrations. SAPs can also be used to illustrate some informal demonstrations for which one may ordinarily use the blackboard. One such use is illustrated in Quantifier Negation Rules SAP, where a simple demonstration is used to show that the statement "Everything is uncertain" implies the statement "It is not the case that something is certain." The universe of discourse is represented with a big rectangle divided into smaller boxes representing objects. A black box stands for an object's being uncertain; a red box stands for an object's being certain. The demonstration begins with the assertion that everything is uncertain, which is illustrated with the individual boxes filling in with black. Then the question "Is something certain?" and an appropriate representation of what this would mean appear on the screen. After a pause (awaiting an answer from the students), it is answered appropriately.

Other Uses: Teaching by Fun. It is common wisdom among teachers that no matter how well-prepared, well-thought-out and well-presented the material is, only rarely do the cognitive aspects of the presentation keep the students' attention. Humor is one way to break the monotony, voice modulations another. Unexpected role playing is yet another. And SAPs can play their part too.

While the possibilities are potentially endless, a good example of what can be done includes the use of whimsical graphical figures that enhance the points made in the SAP. I describe two ways of employing such enhancements, one of which is more ornamental, merely serving to break the monotony, the other of which is in addition more involved in the presentation of the material.[1]

- The presentations on inference rules include sections on how *not* to apply the rules. Such a section may be "spiced up" by graphical means. Some of the ones I have employed include changing the background of the slides from blue to red (only in the title slide, though), as well as including thematically appropriate graphics: hell-fire and an ass. (Incidentally, it is probably best to show the presentation twice. For the first time, only the section on how to apply rules ought to be shown. And only after the students have had some hands-on experience applying the rules (ideally when they committed some of the mistakes depicted in the SAP), ought the section on how not to apply the rule be shown.)
- The SAP on Categorical Quantifier Negation Rules (Figure 4) uses a graphical figure in a more essential way. It introduces a character named Stupido. (His appearance is the result of transformations of the character by the generic name "Man" in the Cartoons section of the MS ClipArt Gallery). Stupido, as his name suggests, is prone to saying exactly the wrong things at exactly the right times. So, when the categorical proposition "Some students like logic" is asserted, Stupido opens his mouth and says "No students like logic." Thereupon, the Hand of Logic squashes him, and a tilde is added in front his claim.



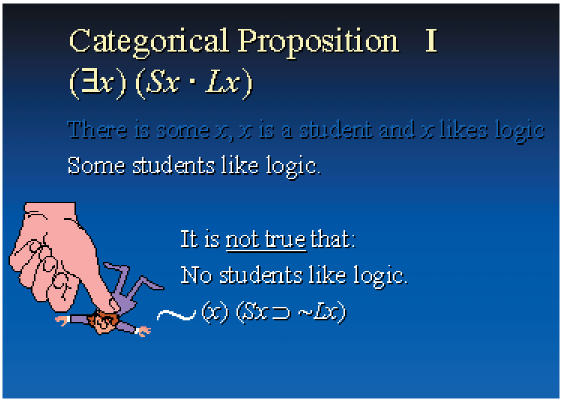


Figure 4. SAP illustrating Categorical Quantifier Negation Rules

Although it is hard to convey the details of SAPs, the general idea behind them ought to have become clearer. They are short presentations that use animation and color to illustrate and emphasize logical concepts and techniques. I should also mention that while the use of animation and color is inextricably linked in SAPs, many of the advantages of SAPs can be obtained by using color chalk or color transparencies. Moreover, many of the metaphors that have acquired picturesque representations in SAPs can be used in oral presentation. This is in fact the origin of many of the metaphors I have implemented. I have been suggesting that students think of variables as boxes, of the antecedent-formula having to be "locked in" before Modus Ponens is applied, and so on.[2]

Essential Limitations of SAPs

Perhaps the single most important limitation has already been mentioned and is ingrained in the name. SAPs are *short* animated presentations. I have been tempted to replace the use of blackboard altogether with a computer presentation. Thus, I conceived of long presentations that consisted not only of material for actual SAPs but also of material that would be usually presented on the blackboard or on regular transparencies. (Such Complicated And Long Presentations are referred to as CLAPs below.) Here are some reasons why SAPs are preferable to CLAPs.

- The primary advantage of a SAP is that it is an instrument of emphasis as well as that it provides a break from a certain kind of monotony of regular instruction. If a long presentation (which included the material from SAPs) were used as part of regular instruction, these two effects would be lost. The CLAP would acquire a monotony of its own.

- Contrary to expectations perhaps, the viewing of a computer presentation requires a rather focused attention. Watching a long presentation may be simply too tiring, while switching between regular instruction and the viewing of SAPs can be stimulating at a very basic pre-cognitive level.
- As I mention below), SAPs are easier to view with the lights off. This makes taking notes (as would be inevitable in a CLAP) rather difficult.
- Yet another argument for using SAPs but not CLAPs is that it is rather hard to make such a computer presentation interactive. If a student asks a question, though the presentation can be stopped, its flow is disrupted. Moreover, there is no way of taking into account the impact of the question.
- This is related to another disadvantage this time of both SAPs and CLAPs. They are extremely inflexible. They have to be prepared ahead of the class presentation, and they cannot be changed on the spot. In fact, given the amount of time required to make them, they have to be prepared a *long* time before the presentation is made. This makes introducing even minor adjustments rather time-consuming.
- SAPs can be easily repeated. This is much harder to do with a fragment of a CLAP, at least when it is prepared in PowerPoint.
- Perhaps one of the most important advantages of using the board for instruction is that the student actually watches exactly what the teacher is doing down to the (seemingly) insignificant detail of which line and what symbol is drawn first. In a computer presentation, even if one is careful to animate and time the presentation so as to reflect the way that the regular demonstration would proceed on the board, something is lost. While it would be interesting to have an understanding of what exactly is lost (perhaps the students "empathize" with a teacher in a way they do not with a computer?), the two ways of presentation are significantly different. I have only anecdotal evidence for this claim, though the particular incident described does seem to make sense of a number of teaching episodes (from both sides of the lectern).

  The incident in question occurred when I was using transparencies to introduce truth tables. By then, the students were already able to calculate truth-values of a complex sentence given the truth-values of the simple sentences. The only innovation was the conceptual one of taking into account all possible truth-values of simple sentences (as well as the corresponding representational one of constructing the base of the truth-table) and the representational one of organizing all this into a truth table. After introducing the general concept and explaining how to construct the base of a truth table, I have shown the students a simple transparency with a neat truth table, explaining all its elements. We filled in all the truth-values row by row, together. We worked through another example, once again on the transparency. Then I asked the students to do another example in groups. I got uniformly puzzled looks and the request “Could you show us an example first?” And they did in fact proceed to work on their own after we did one truth-table on the board, drawing all the lines from scratch, putting in all the sentences where they belong, etc.

This suggests that at least sometimes there is a danger of going too far in replacing what can be done on the blackboard with what can be done more neatly and seemingly more clearly by means of other media. It also indicates that it is much safer to use SAPs rather than CLAPs.

- One final point worth making, which further supports the suggestion that SAPs ought to be used only to supplement regular presentation of the material, is that they ought to be conceived as offering optional ways of understanding the material. The hope is that the metaphors they present can attach themselves to the students’ conceptual structures more effectively than could regular instruction on its own. But this may be a very individual matter. It may work for some students but not for others. So, it should be emphasized to the students that SAPs are not meant to be a part of regular instruction, which means *inter alia* that the students must not be accountable for them. Whether they pay attention, catch on to a metaphor so that it will become helpful to them, should be left entirely without any formal testing procedure. They should watch SAPs for fun, not for grades.

Although this enumeration of advantages and limitations of SAPs cannot pretend to be complete, it illustrates their value as tool for enhancement rather than replacement of regular ways of presenting material. The discussion seems also to indicate that SAPs should be used only after a regular presentation of the material, and perhaps even only after the students have had an opportunity to try out the application of the concepts and techniques themselves.

Technical Limitations

I have already mentioned some limitations of a technical nature in passing. Let me bring them together. They fall into three categories: limitations of software, of hardware, and some technical ramifications of their employment in classroom instruction.

While MS PowerPoint 95 does have some animation capacity, it is somewhat of an abuse (of the program and of the user) to use it with view to creating animated presentations. Its poor performance in this capacity should come as no surprise since it is not a software package designed for this purpose. Newer versions of MS PowerPoint (starting with 97) have a macro language that helps with the automation of some tasks. But only the recent MS PowerPoint XP provides an animation facility that constitutes a major improvement for the purpose of creating SAPs. It allows one to move items along a prespecified paths.

The speed of the presentation is very sensitive to the computer one uses. One problem that is worth emphasizing is that the presentation will appear differently depending on the speed of the computer it is run on. What is basically a transparent animation on one computer can become a blur when run on a faster one or almost unanimated struggle of the computer when run on a slower machine.

Aside from software and hardware limitations, there are also some technical aspects of classroom use that merit attention. Although the presentations can be run when the lights are on, their visual appeal is significantly enhanced when the lights are off. This means that SAPs will work effectively only in case where the teacher has an easy access to the light switch. (The first classroom in which I presented SAPs provided the added entertainment for the students as each viewing was preceded by the instructor clumsily slaloming and tumbling over rows of chairs to get to the light switch placed at the opposite end of the room.) Moreover, the actual technical equipment required can be rather distracting if it is not properly placed in the classroom. The whole apparatus I have used was placed on a rather high cart-wheel which was either in the view of the students so that they could barely see the presentation or else, when moved away, distorted the shape of the projected image.

Future Prospects

I find the idea of enhancing the teaching of introductory logic with SAPs very appealing. Whether it will pass muster only experience can show. But it is also exceedingly clear that it would be very hard to develop a complete set of SAPs on one's own.

If there were even a few people who would be interested in both using and developing SAPs, it would be sensible to establish an electronic library thereof. Such a library would have several advantages. First, it would considerably ease the pain and time involved in developing SAPs. At the same time, since SAPs are revisable, each and every user could use an existing SAP to modify it to fit his or her own taste or system. Second, the creation of really effective SAPs is not an easy matter. This is particularly so because we have very little insight into the way in which forms of representation feed into the process of understanding and, consequently, into the process of education. For example, it might be that there are better and worse ways of choosing a representational metaphor for a particular derivation rule. As an example, I might mention that I have struggled with two ways of representing the De Morgan transformations in the direction other than the one already mentioned (transforming a disjunction/conjunction into a negation). One involves the second tilde clashing with the wedge, say, and becoming transformed into a dot, while the first tilde jumps in front of a parenthesis. The other involves all three connectives flying over to one spot, where they clash and become transformed into one tilde and a dot, and then move to respective places. Neither of these strikes me as being particularly helpful (though I find the second preferable). By having some sort of forum for exchange of ideas, the chances of finding really effective SAPs would be greatly increased.

If such a forum were to be organized, it might be reasonable to try to find different software. The problem, however, is that of balancing the sophistication of the software, on the one hand, and its accessibility and cost, on the other. The enormous advantage of MS PowerPoint is that together with the other MS Office programs it has become something of a standard and is available in many computer labs, offices and homes.

Notes

1. All the graphics used come from the MS ClipArt Gallery. Since MS PowerPoint allows to modify the graphics, some of the graphics used are the result of such modifications.)
2. I have inherited many of the metaphors from my logic teacher, Ken Manders.

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