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Overhauling Technical Handouts for Active Student Participation: A Model for Improving Lecture Efficiency and Increasing Attendance

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This instructional paper is intended to provide an alternative approach to developing lecture materials, including handouts and PowerPoint slides, successfully developed over several years. The principal objective is to aid in the bridging of traditional "chalk and talk" lecture approaches with more active learning techniques, especially in more technically-oriented disciplines that employ data or require carefully structured graphs or mathematical manipulation. Using several examples, the paper shows how scarce lecture time can be used more efficiently, thus freeing up students to focus on higher order cognitive issues. Such an approach lends itself to more active-centered techniques. It also improves the incentives for students to attend lectures. The approach is time consuming in its initial development, but arguably pays for itself over the long run.

Recently developed technologies of all kinds are making their way into the modern classroom. For example, document cameras have become more sophisticated and versatile than traditional overhead projectors, "smart" whiteboards allow for more spontaneous interaction with any sort of projected material, and the recording of lectures for remote viewing has become commonplace. Students communicate increasingly via online systems (e.g., Blackboard and the like), while audience response systems, such as "I>Clicker", allow even large numbers of students to provide instant feedback and answer questions in real time (see, e.g., Lucas, 2009; or Meedzan & Fisher, 2009). "SMART Podium" (formerly known as the "Sympodium") is a hardware and software system that allows the instructor to actually write over any material on a computer screen, such as a PowerPoint slide, using an electronic stylus or "interactive pen" (see, e.g., Strong & Kidney, 2004; Shafer, Simon & Liemer, 2003). Also, even though the practice is hardly widespread, computer algebra systems, such as *Maple* or *Mathematica*, are beginning to find their way into lectures (see, e.g., Raymond, Raymond & McCrickard, 2008).

While the utilization of these most recent technologies is growing in the classroom, they are hardly a panacea for all that ails traditional instruction. First, the true efficacy of these technologies on comprehension and learning are, as of yet, little studied. Second, regardless of the allure of the modern (Here is where this paper may be mistakenly characterized as "reactionary".); there will always be a place for traditional modes of delivery in the classroom. Indeed, some material will undoubtedly always require some version of "lecture-style" instruction, which is to say students attend lectures in which instructors *show* how some routine is performed, or *guide* the learning process. To suggest otherwise would seem to deny that teachers have anything to teach.

This view hardly rejects the usefulness of new delivery modes. In fact, the most productive approach is presumably one that sees these new modes as potentially complementary to traditional ones, or vice versa. One approach does not have to be the enemy of the other: the present author has productively incorporated a number of technological advancements into the classroom and enjoyed doing it. The departure point of this paper, simply put, suggests aspects of the "old" forms of instruction are not likely to disappear anytime soon (see, i.e., Becker, 1997, p. 1361). In fact, the overriding objective is to help make the "old technology" more effective and to bridge some gaps between the old and the new.

This paper focuses on a technique for improving the effectiveness with which a lecture can be delivered, as well as the effectiveness with which students might retain lecture material, particularly in the context of more technical matter. In addition to making lectures more efficient, the approach also increases the incentives for students to attend class *and* to participate. In other words, this approach integrates more active learning with aspects of the traditional lecture.

The proposed method is an improvement on an older mode of lecture delivery, that mode being lecture handout notes or downloadable PowerPoint slides that students print off and bring to lectures. The technique is applicable to both lecture handouts that are distributed by the instructor (and used in conjunction with overhead projectors), and to PowerPoint slides. The discussion will, however, tend to focus on lecture handouts rather than making constant and cumbersome references to both modalities throughout the paper. I will return to specific suggestions for PowerPoint later in the paper.

Active Learning

The very term "active learning" suggests effective learning is more than just "showing up" for a lecture.

To be engaged in active learning, "They must read, write, discuss, or be engaged in solving problems. Most important, to be actively involved, students must engage in such higher-order thinking tasks as analysis, synthesis, and evaluation. … [S]trategies promoting active learning [can therefore] be defined as instructional activities involving students in doing things and thinking about what they are doing" (Bonwell & Eison, 1991: 1). While it is not always clear exactly what is being measured when comparing active learning outcomes to traditional ones (Prince, 2004), there seems to be reasonably strong evidence that certain active learning techniques improve learning outcomes (see, e.g., McKeachie, Pintrich, Lin & Smith, 1986; Ruhl, Hughes & Schloss, 1987; Hake, 1998; Redish, Saul & Steinberg, 1997; Laws, Sokoloff & Thornton, 1999; Bransford, Brown & Cocking, 2000).

Following his review of the learning literature, Saunders (1998), for example, recommends standard lectures be augmented with rapid feedback. This latter point is consistent with a key finding in effective teaching: addressing student misconceptions early and often (Bransford et al., 2000). Other techniques that Saunders suggests improve the learning process include visual aids and exercises that emphasize interpretation and application over memorization.

In addition to bridging the gap between more traditional lectures and active learning, the current paper argues that the techniques proposed below are particularly effective across a number of the suggested measures, above. By its very nature, the proposed approach is visual, in the sense that it depends upon lecture handouts that are visually displayed via a projector, as per Saunders' suggestion (1998). But the approach also demands active student participation with this visual modality: students are highly unlikely to absorb this material by sitting passively. The approach is also designed to provide immediate feedback to students and therefore accomplish the goal of quickly mediating student misconceptions. This task is accomplished because of the increased clarity of the lecture material and because the process lends itself to active student engagement. Finally, one of the key aspects of the technique centers on freeing students' minds from tedious transcription of material, especially in demanding technical lectures, so they can use class time more effectively for higher-order thinking and contemplation in real time. The claim, concerning the effectiveness of the proposed techniques, is also consistent with Saunders' (1998) argument that students effectively absorb new material best when they are clear about learning expectations and when that material is linked to already-learned material.

The Theme: Traditional Lecture Handouts

Lecture handouts are quite obviously useful for classroom instruction: they aid students' comprehension of visually or technically complicated material, whether it be graphs, tables, or formulae, and they can aid students' ability to organize lecture material. The problem with lecture notes (and PowerPoint slides), made available prior to lecture is that they can too easily become a *substitute* for the lecture itself (Cohn, Cohn & Bradley, 1995). This substitution means that any careful conceptual evolution throughout the lecture is largely futile because the details of the lecture are laid out for students to peruse. Such a lecture can be compared usefully to the presentation (conference or otherwise) in which audience members have a copy of the paper that the presenter simply reads aloud. Invariably, audience members glance across the paper at a quicker rate than the presenter can read it. After only a few minutes into the reading, the typical audience member knows how the presentation will both develop and conclude. Similarly, one hears student complaints that such and such instructor "just reads the handouts" or "just reads through the PowerPoints." Of course, this is not the worst of it: at least the complaining students are attending class. Lecture notes and PowerPoints used in this manner create precisely the wrong incentives for participation. Students have every reason to skip classes, because, as Cohn et al. (1995) have shown, traditional lecture notes are a perfectly good substitute for the lectures themselves.

The Variation

The simple (but not necessarily easy) variation on the lecture notes theme is one I have been developing for a number of years. I use lecture aids, but in a profoundly altered state from the ones commonly used. I take care to omit all of the most critical details that will be completed throughout the lecture itself. In other words, these handouts (or PowerPoint slides) offer the main contours of the lecture, thus assisting students in the organization of the material, both in real lecture time and after the lecture is long completed. However, these lecture notes do not give away any of the important conceptual solutions, developments, or surprises that might be employed to keep the lecture interesting. By explicitly not including many of the details of how a topic evolves, the material can be carefully developed by the instructor, step-by-step in real time. Such a process encourages student questions as the instructor physically, and mentally, works through concepts and problems (assuming spontaneous questions are allowed).

Figure 1
Data Table as Source for Graph

Total Product (TP) & Marginal Product (MP): A Numerical Example

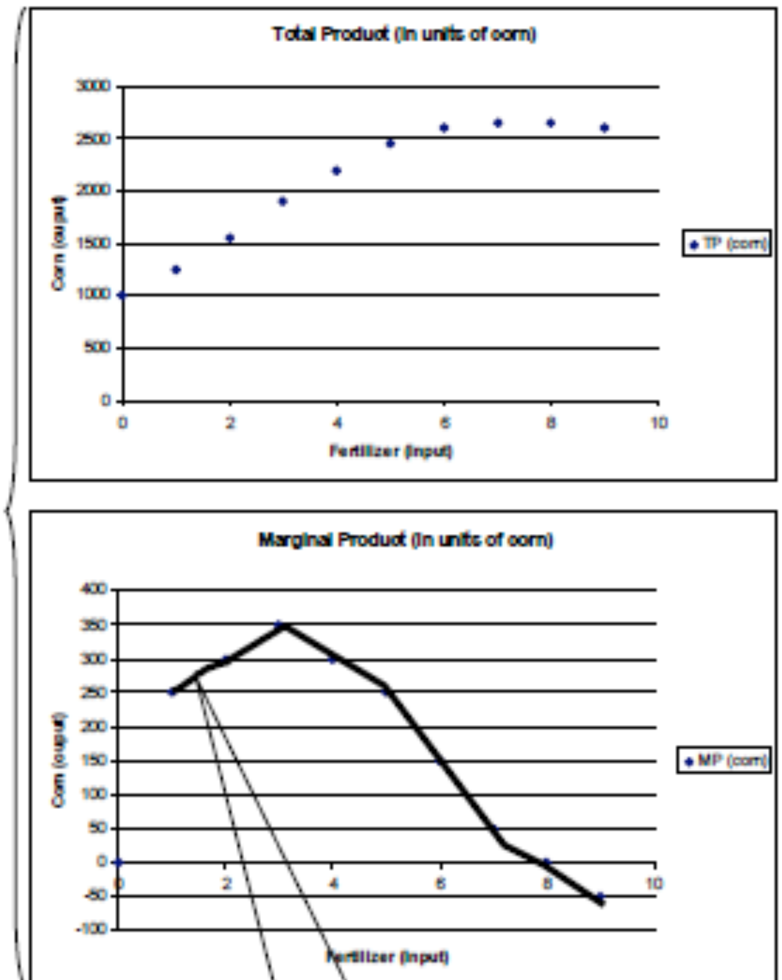
(A)

Table 1: TP and MP

Fertilizer (input)	Corn – TP (total output)	Corn – MP (marginal output)
0	1000	
1	1250	250
2	1550	
3	1900	
4	2200	
5	2450	
6	2600	
7	2650	
8	2650	
9	2600	

Column completed in lecture

(H)



Interpret the "Law" of Diminishing Marginal returns…

(B)

Drawn freehand in lecture

In many technical fields like economics, there can be a considerable amount of algebra, data, graphing and use of tables. Each of these tools can take significant time to transmit from instructor to student. Simply setting up the problem, or providing background data for the problem of focus, tends to absorb precious time. A simple example is the use of data – frequently listed in table form – that will be used to perform some specific function, or to provide material for graphing. Writing out the data itself is likely to be a completely superfluous task, in intellectual terms, and is therefore wasteful of both the instructor's time and students' time. The transcribing of such data by students, while not as "passive" as sitting in the classroom with arms folded, is hardly what comes to mind when we think of "active" participation or the development of higher order cognitive skills.

This situation provides an excellent illustration of the usefulness of handouts that include tables of the relevant data. The instructor spends no time dictating the data, and students spend no time writing out the data. Many graphs present the same issues. It can be very tedious and inefficient to set up every graph that might be used in an economic lecture from scratch, including the axes, units of measurement, and particularly scale, for example. Indeed, it is likely that some of the most important obstacles to students' comprehension of technical economic material is the difficulty of correctly organizing graphs and the like (Cohn & Cohn, 1994). Frequently, they set up their graphs and initial equations incorrectly from the start, which can lead to a cascade of confusion, not only in the lecture itself, but also when they return to the material later to study. Even when they do set up technical material correctly, it consumes valuable class time. In sum, attention to an array of niggling, non-critical, technical details consumes scarce time that is better spent on student-instructor communication or the development of more complex intellectual skills.

Several figures illustrate a number of the points discussed (see Figures 1 through 4). The handouts typically include major headings of the topics to be covered, and frequently include new terms and concepts, but usually without definitions (see points *A* and *B* in Figure 1). This gives the instructor the opportunity to develop the definitions as the concepts evolve throughout the lecture (see point *C* in Figure 2).

Consistent with the objective of reducing tedious transcription, it is also useful, on occasion, to provide lengthier definitions (see point *D* in Figure 2). When it comes to algebra and formulae, a list of variables and their definitions can be provided (see point *E* in Figure 3). Moreover, the provision of an initial equation assures not only that the problem is set up correctly with appropriate syntax, etc., but also that class attention is properly focused (see point *F* in Figure 3). Enough open space should be left on the page for the students to complete any solutions or problems that are worked through in real time (see point *G* in Figure 3).

When it comes to graphs specifically, providing at least the starting axes – and additional details as necessary – will allow the class to move immediately to the lecture point at hand (see point *H* in Figure 1 and the graphs in Figures 2 and 4). This permits the instructor to work through the solution using a duplicate overhead slide (or PowerPoint slide), which reproduces the same initial axes, etc., from the students' handout. If the class is examining the properties of a particular curve, such as the interpretation of its slope, or the graphical properties of some algebraic expression, it is able to move immediately to that objective (see point *I* in Figure 2). If there is a particular diagram that gets increasingly complicated, several versions of it can be provided in various states of development that, in each successive diagram, the instructor can concentrate on the specific nuance (in Figure 4, see the transition from panel 1's "Exchange in an Edgeworth Box" to panel 2's "Efficiency in Exchange"). This technique avoids the need to heap too much technical detail on any one graph, which can make such a graph nearly impossible for students to interpret later.

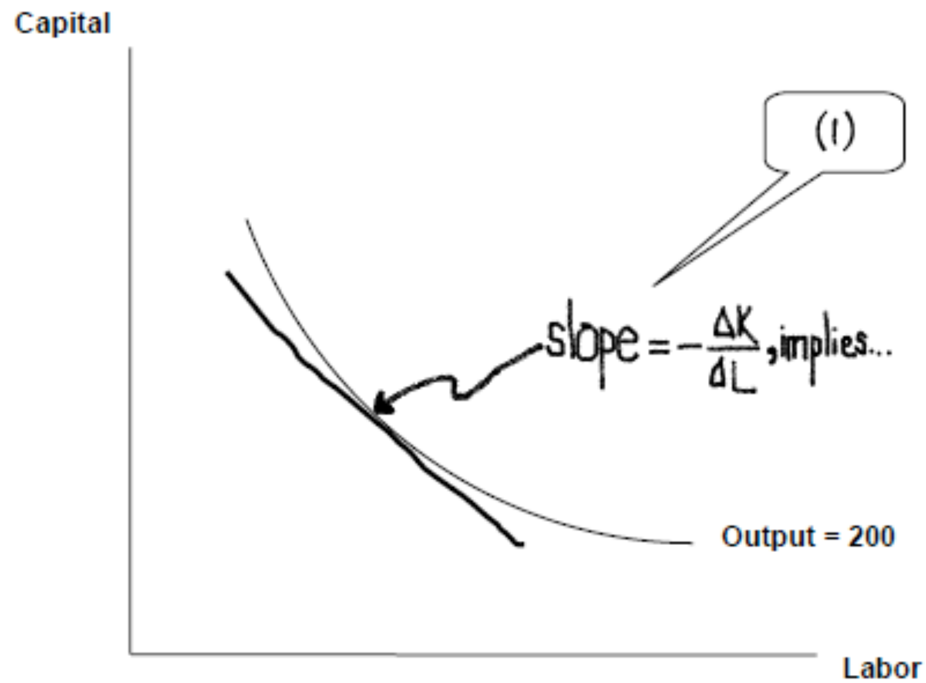
Back to PowerPoint

Coming back specifically to PowerPoint, its popularity is indisputable. Indeed, it has become uncommon to pass large lecture halls where PowerPoint is *not* being used. Many large publishers are including PowerPoint lecture slides as part of their instructor resources. They tend to be visually appealing and they certainly can cut down on the amount of time needed for lecture preparation.

The problem is their effectiveness is questionable. Ahmed (1998) conducted a study in which a lecture was delivered to two groups of students, one in which traditional overheads were used, the other in which a colorful PowerPoint presentation was used. Data analysis indicated little difference in test scores between the two groups of students. "The study suggests that technology is not a magic bullet, and what is most important in the classroom is a good teacher" (p. 5). Bartsche & Cobern (2003) challenge the idea that students prefer more technologically advanced modes of lecture delivery. Their study examined "expanded" PowerPoint presentations, which include not only text, but pictures, sounds, and text appearing in different ways. They found "there is no significant difference between the three groups," i.e., transparencies versus "basic" PowerPoint versus "expanded" PowerPoint, in how much students liked the lecture (p. 81). They conclude it is often "administrators [who] are pushing for instructors to use

Figure 2
The Organization of Concepts with Reference to a Graph

Analysis with Two Variable Inputs



Isoquant

Is a curve showing ...

Characteristics:

1. higher curves illustrate . . .

2. slope…

(C)

Marginal Rate of Technical Substitution (MRTS) = measures the change in one input needed to keep us on same *isoquant* when we vary the other input by a small amount

(D)

3. convexity…

Figure 3
Starting Equation Listed with Variable Definitions

Examine the following equation:

$$dQ = (\partial Q/\partial L)dL + (\partial Q/\partial K)dK$$

Model and variables:

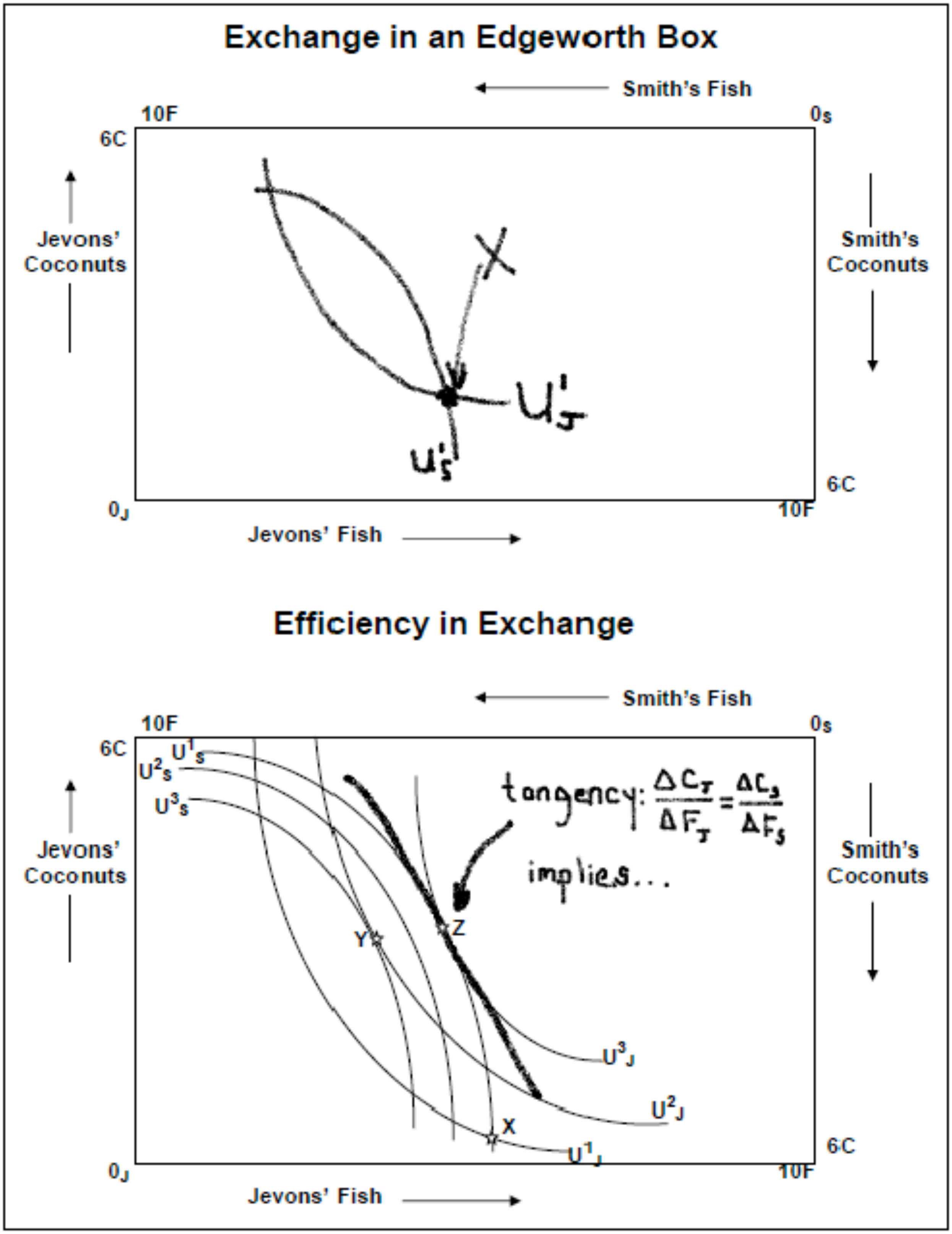
dQ ≡ Total Derivative of Production Function

$\partial Q/\partial L$ ≡ …

$\partial Q/\partial K$ ≡ …

Solve for slope and interpret

Figure 4


Exchange in an Edgeworth Box
Smith's Fish
10F
0s
6C
Jevons' Coconuts
Smith's Coconuts
X
U'J
U's
6C
0J
10F
Jevons' Fish
Efficiency in Exchange
Smith's Fish
10F
0s
6C
U1s
U2s
U3s
Jevons' Coconuts
Smith's Coconuts
tangency: ΔCJ/ΔFJ = ΔCS/ΔFS
implies...
Y
Z
U3J
U2J
X
U1J
6C
0J
10F
Jevons' Fish

this kind of technology" (p. 78). Bartlett, Cheng & Strough (2000) found that student performance decreased when instructors switched from transparencies to PowerPoint.

The argument here is traditional PowerPoints have suffered from many of the same ills that have beset traditional lecture handouts. Moreover, the "canned" slides that come from the publishers tend to be "clunky": there is usually too much material per slide and an excessive number of slides per chapter. There are frequently small annoyances that can equate to large pedagogical issues, such as a lack of "click to appear" lines of text: as noted above, showing *all* the material on each slide at once is likely to have the audience reading well ahead of the instructor's pace, thus defeating any intention the instructor may have to methodically "develop" concepts. In the case of economics, PowerPoints are often not well paired to the technical development of the material, which is to say the slides often present already-completed graphs that are exact reproductions of those found in the textbook. In other cases, they provide the final algebraic solution to some problem without including any intermediate steps in obtaining the solution. Naturally, this precludes any "building up" of the material, piece-by-piece, in a way that allows students to focus on each step of the solution process. Again, the "active" part of the learning process is – due to the nature of such prepared slides – nearly impossible to foster in such a framework.

While there is some progress being made in this area, these slides are still not nearly as nuanced as they need to be for the appropriate pedagogical presentation of the material. In sum, PowerPoint poses all the same problems noted above: the instructor essentially reads the material, which leads to student passivity and boredom. There is, moreover, little reason to even attend lectures if the complete lecture slides are made available.

Fortunately, the approach to lecture handouts, suggested above, is equally applicable to PowerPoint. Using the same guiding principles, instructors can delete enormous amounts of material or hide the "punch line" in the students' downloadable version of the slides, only to have it appear in the overhead lecture version. Instructors should, of course, fix text to "appear on click," so the entire slide is not visible all at once. With some practice in PowerPoint tools and in Microsoft's drawing tools, it is also possible to pare down the initial presentation of graphs (i.e., the axes, etc.), in the student version, so the process of developing the graph can take place in real time along with the instructor. This way, the complexities of the graph are developed in the context of the lecture itself.

For algebraic solutions, it is often necessary to provide the initial problem set-up, as suggested earlier, and return to the whiteboard to work out the intermediate steps in detail. These can also be included in the overhead, i.e., instructor's version of the PowerPoint slides while leaving them out of the student handout versions, if they are not too onerous to reproduce electronically. However, simply clicking through lines of algebra in PowerPoint neglects something fundamental in technical topics: students often need to see, in detail, how someone more expert than they are works through the various nuances of particular problems. Indeed, instructors are forever telling students they need to "show their work." Students need to see instructors showing *their* work, thereby conveying the subtle but important point that *process* is critical to learning, not simply results. This real-time solving of mathematical problems (and other technical material), by its nature, begs students to ask questions about this or that step throughout the process. This approach can therefore bridge more traditional delivery systems with active learning, especially if the instructor constantly prompts students to answer questions along the way, such as, "Can you walk me through the next step in the process?" or "What would we do next, and why?"

And New Technology…

A quite useful technological advancement is the "SMART Podium," which, as noted above, allows the instructor to hand write over any material on a computer screen, such as a PowerPoint slide, using an interactive pen. The instructor is therefore able to provide the initial problem in, say, PowerPoint – exactly as suggested above in the context of handouts – *and* work through successive intermediate steps on the computer, by hand, in real time. All of the instructor's notation around the initial equation or graph is displayed on the projector for students to follow. The final result, which combines the original slide and the in-class handwriting, can then be saved to a file for later reference or distribution to students. In sum, PowerPoint can indeed be adapted to better fit the pedagogical demands of the classroom, but it may require a few more technical skills, especially in the case of presenting technical material.

The Benefits

As noted above, the point of the proposed approach is to improve the efficiency of scarce lecture time. Besides cutting down on menial transcription during the lecture itself, these notes actually maintain students' interest by providing them with the organization of a specific lecture, including the topics that will be covered; this gives them a "roadmap" for the lecture and thus allows them to orient themselves at any point during the lecture without knowing the answers before the instructor has even gotten to the questions. In addition, the students end up with something akin to a neatly-organized workbook that is completed as the semester progresses. Such a workbook aids in their organization of the entire semester's material and, as a result, their studying. My own students have overwhelmingly appreciated the approach and have registered their satisfaction on teaching evaluations over a number of years and across several universities.

The second point of this approach is to reduce the incentive for students to skip class. A very important feature of these lecture handouts is they are useless without coming to class. Because upwards of 80% or 90% of the material is presented *in the classroom*, obtaining the handouts cannot serve as a substitute for the lecture itself. Indeed, as Becker (1997) suggests, "Note taking and graph drawing are stepping stones to activities that require student involvement. If nothing else, they forced students to attend class, assuming class notes are not available elsewhere" (1997, 1362). The point is in economics classes, and presumably in many other technically-oriented ones, the typical student is unlikely to get the experience and instruction necessary in activities like graph drawing on their own by simply reading the book (or obtaining traditional all-inclusive lecture handouts for that matter). The proposed approach to lecture handouts encourages students to attend class by making the classroom instruction of these topics easier, more accurate, and potentially more enjoyable.

Third, this method implicates students as active participants in the lecture. The nature of these handouts compels them to take part in the delivery of the learning unit. By providing a roadmap for the lecture, the approach allows students to anticipate the direction of the topic without being handed the final solutions or pedagogical punch lines. Unlike the traditional lecture, their ability to anticipate developments encourages them to participate more actively in the process of delivering the lecture – at a minimum, intellectually. Naturally, the instructor can incorporate an array of other active learning strategies, such as a dialogue method or a problem-based method, to further encourage this participation. Such a process helps to avoid the problem, in many traditional settings, that students are necessarily one step (or more) *behind* the instructor at all times. Instead, an aspect of the topic is delivered and, with the aid of these carefully targeted handouts, students apply the various pieces of knowledge to arrive at the next step in the conclusion, which the handout prompts. The process is carefully choreographed so students can feel as though they are a step ahead of the instructor instead of waiting passively for the next piece of information to be handed to them. The method is obviously more demanding of students since, it forces them to stay with the instructor as he or she progress through the material, but this is precisely what active learning requires.

Finally, this approach forces the instructor to spend more time, at least initially, carefully organizing lectures. This requirement is undoubtedly obvious, but it is worth articulating the fact that it demands close attention to the material that will be displayed for students versus the material that will be left for the classroom process. As a result, these handouts produce highly structured outlines for class meetings, which, incidentally, conform to one of the principal characteristics of active learning: that students absorb new material best when learning expectations are clear and when that material is linked to previously-covered material (Saunders, 1998).

In wrapping up this section, it is worth noting that while this paper has referred to these lecture aids as "handouts," it is almost wholly unnecessary to physically hand out anything anymore. Given the convenience and efficiency of the Internet, it is easy to make these outlines available on course web pages (or Blackboard) prior to lectures. Students know they are responsible for downloading and printing the material themselves, and they also understand that lectures are structured around the handouts. In fact, students typically find they depend on these abridged handouts even more than on other modes of lecture because so much of the material is built around them. This close dependence on the handouts can actually increase students' responsibility for their classroom activities, as they have to come to class having downloaded the day's material, or suffer the consequences of running behind the rest of the class. Indeed, it is my impression, purely anecdotally, that students are more organized in the classes in which these handouts are used than in those in which they are not. Incidentally, because students are responsible for printing their handouts, the technique has the added advantage of reducing what used to be an expense for the university in terms of photocopying and paper.

The Costs

This approach is clearly not without costs. It is admittedly time consuming, particularly in the initial preparation of the material. In the case of PowerPoint, it is obviously much more cumbersome than simply pulling textbook PowerPoints "out of the box." Because of the initial costliness of preparing these handouts or PowerPoints, this approach is more likely to appeal to instructors where high quality teaching is both expected and valued. Where quality of teaching is not appreciated, its *start up* costs are likely to prove too burdensome for instructors.

However, while start up costs are high, lecture prep is actually less time-consuming in subsequent course offerings. Indeed, these handouts have the benefit of providing an excellent template for successive classes, and while the material can be refined over time, the alterations tend to become less dramatic (and time consuming) in later iterations. While it would be difficult to calculate precisely, it may well be this approach is actually less costly in terms of overall lecture preparation, when considered over several years of teaching a particular course.

Conclusion

This paper was intended to provide an alternative approach to developing lecture materials, including handouts and PowerPoint slides, that has been successfully utilized over a number of years of teaching. Using a number of specific examples, the paper showed how scarce lecture time can be used more efficiently, while simultaneously creating incentives for students to attend lectures. It was argued that by making lectures easier to follow, and classroom tasks less tedious, these lecture aids create incentives for students to actually attend class more often. It also creates incentives for students to actively participate in the development of the lecture itself for a number of reasons. The gains from this approach are likely to be greatest in technical disciplines requiring a reasonable amount of carefully structured graphs and mathematical manipulation. The approach is time consuming in its initial development, but can pay substantial dividends over successive terms.

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