Designing Online Course Materials Based on Student Preferences in Using Learning Resources

Presented at the meetings of the
American Economic Association
San Diego, CA
January 5, 2004

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The increasing use of online learning tools in economics instruction has dramatically changed our thinking about how students might try to learn course content. The diversity of learning tools, from interactive, online textual materials, to streaming video, to chat rooms and discussion boards, means that students have many more choices in an online or hybrid course\(^1\) than they had in a more traditional face-to-face environment. This paper explores the theory of student choice in richer learning environments, and presents data on how students in an online microeconomics course actually make choices about a variety of learning tools. These results allow us to offer some prescriptions for ways we can improve learning environments.

**A model of student learning**

Our approach is to consider the student's learning choices in the context of a constrained optimization problem in which each student tries to maximize the amount learned in a course subject to a time constraint, and subject to what we call a "cognitive style" constraint. Basic elements of the model appear in Brown and Saks (1975, 1981).

A student's cognitive style embodies, among other things, the student's ability, past learning in the subject, and other learning characteristics. A student's having a cognitive style is analogous to the student having a production function for learning, and indeed the cognitive style determines the underlying shape of the learning curves or the student's production function for learning.\(^2\) The cognitive style and time constraint allow us to find a learning possibilities curve for each student.

To assist our thinking about the model consider the simple case of two students who can learn a subject using two learning tools. Examples of learning tools would be engaging in activities such as reading a textbook, or attending a lecture. Instructional
technology has expanded the number and kind of tools available to include online quizzes that may be customized or randomized for individual students, streaming video lectures and slides, as well as games that engage the students in ways very different from the traditional face-to-face classroom. Using the individual student learning curves for each student using each tool, and given the total time each student spends on the course, we can find learning possibilities curves for each student.

Examples for the linear case are shown in Figure 1, which depicts learning possibilities curves A'A" and B'B" for two students, A and B, who have available two learning tools. Each student's learning possibilities curve shows the maximum learning from using one of the tools, given an amount of learning using the second tool, and given the time spent on the course. We assume the axes measure the learning from each tool, and have the same scale, so the 45-degree line shows all combinations of a student's learning for which the sum of learning from the two tools is constant. Student A's learning possibilities curve, because it is steeper than the 45-degree line, shows that student A has a comparative advantage in using learning tool 1, and maximizes total learning by choosing point A', specializing in the use of tool 1. Student B, by contrast, will specialize in the use of tool 2, and have a total learning level of B".
Anyone with a passing familiarity with the textbook treatment of the basics of comparative and absolute advantage will see an obvious similarity between this analysis of learning and the standard explanation of the theory of specialization and exchange. Except that in the case of learning possibilities, there is specialization but no exchange.

To carry the analysis, and the analogy, a bit further, we can see that a student can have an absolute learning advantage in using one or both learning tools. For example, that student B has an absolute advantage in using tool 2 shows up as B" being greater than A". Having an absolute advantage means that the student is, in some sense, "smarter," or better prepared, or devotes more time to learning. But as in the textbook example of trade and exchange, it is comparative advantage that matters for understanding student resource allocation, and it is comparative advantage that offers the chance to gain from specialization.

Figure 2 shows a non-linear case of the learning possibilities curves for two students and two learning tools. The non-linearities might be due simply to diminishing
returns to using a learning tool, or due to an interaction between tools – going to lecture may alter the learning curve for reading the textbook.

For the learning curves shown in Figure 2, each student will maximize total learning from the tools by choosing the point of tangency between the forty-five degree line and the learning possibilities curve. In the figure, student A, while having a cognitive style that favors using tool 1, will use both tools in learning. In general, the convexity of a learning possibilities curve makes it more likely that a student will use more than one tool to learn.

Now suppose that initially only one of the learning tools is available, say tool 1, so that student A will learn amount \( A' \), and student B will learn amount \( B' \). Creating the second tool will allow student A to achieve \( a_1 + a_2 \), and student B to achieve \( b_1 + b_2 \). Creating the second tool will not only increase learning for both students, but it would increase learning for both students even if they had the same learning styles with respect
to the tools. So diminishing returns or interactions between the learning tools could alone justify introducing a new tool.

The model suggests several guidelines for course design. Most of these flow directly from the existence of different cognitive strategies across students.

First, in the linear examples of Figure 1, if the students in the course all have learning possibilities curves with the same slope, then only one tool will ever be needed to maximize total learning. So it is the diversity of cognitive styles that makes the use of multiple tools an optimal strategy.

Second, the more likely case of the non-linear learning possibilities curves of Figure 2 suggests that students will choose multiple learning tools to achieve their objectives. They will not, in general, be expected to specialize in the use of only one tool. This will come as no surprise to economists who characteristically devise their choice models to explain that sort of diversifying behavior. And we will see in what follows that students do indeed take advantage of multiple learning tools.

Third, the size of the gain from having multiple learning tools depends on the magnitude of the difference in their relative advantages for the students. When cognitive styles differ greatly, using tools that are very similar to each other in terms of their productivities are unlikely to yield much total gain in learning.

The learning tools in a course should be created or chosen to maximize the gains available to students with diverse learning styles. This means creating tools that are in some sense complements rather than substitutes for each other, so that they take advantage of a diversity of cognitive strategies that exist among students in a course. Another way to say this is that for a given distribution of cognitive learning preferences,
tools should be as different in their comparative advantages as we can make them. Such as strategy would work to the advantage of classes that have very diverse cognitive preferences.

Finally, we must remember that the choices in our simple model must be viewed in the context of a more general time allocation model for students. Total time devoted to a particular course is not an exogenous variable, but is affected by the costs and benefits of allocating time to all activities, including such things as work, leisure, and other courses. Any general analysis should take into account these other factors.

**An online course in microeconomics**

When we first designed and constructed our online microeconomics course in 1999 we had little experience to draw on, and had only a passing familiarity with the theory of online instructional design and pedagogy. What we did have was over 70 years of classroom instructional experience between us, and a keen awareness of what seemed to work in face-to-face instruction. Indeed, we were both long time, avid experimenters with using new techniques in our face-to-face courses.

So when designing a completely online course we endeavored to make available an especially wide variety of learning tools for our students. In particular, we used a traditional textbook, a very large catalog of media enhanced PowerPoint slides, streaming video lectures, some interactive Excel-based practice problems that were individualized to the students, and a large file of repeatable, low-stakes practice questions similar to what the students would see on examinations.

Our guiding principle was "If we can provide it in the time frame allowed for creation, and it can be done within our frankly quite generous budget, then let's make it
part of the course.\" We created a stew, and it is the many ingredients of that stew that make it a particularly interesting course to study. In addition to the stew ingredients listed above, we seasoned the mix with e-mail and discussion board communication, as well as a help room for those students who were on campus. Without this diversity of the learning resources this study would not be possible.

In the sections that follow we will first describe the course and learning tools it incorporates. We will then describe the evaluation form that generated the data for this study. Finally, we will report the student responses, and analyze how they vary by student ability and class level.

The course tools

Principles of Microeconomics at Michigan State University is usually offered in large sections of from 200 to 600 students each with a total enrollment of from 1600 to 2000 students per semester. The online section, which began with 100 students in fall 2000, currently enrolls 200 students per semester. More than 95 percent of the students in the online section are also simultaneously enrolled in face-to-face courses on the East Lansing campus. In other words, most students taking the online course are regular, full-time, residential students at the university. Because of the high proportion of residential students, all examinations are given face-to-face in a proctored setting for those students. Students who live away from campus are sent the exams to be administered in a proctored, face-to-face setting.

The course was created by the authors and a staff of programmers, instructional designers, and producers in the Michigan State University Virtual University. Our design philosophy at the outset was to offer the students a wide variety of learning materials to
appeal to different learning styles. The course was composed of three groups of learning materials that we called readings, lectures, and activities.

Readings consist of the Mankiw (2002) text, and a series of over 600 media enhanced PowerPoint slides. Thus the students can read the same subject matter in two different formats, though the material is presented in two distinct media – the printed textbook, and the screen display of the slides.

Lectures consist of streaming-video recorded lectures presented with a technology that accompanies each lecture with a synchronized series of PowerPoint slides. (The lecture slides are not the same as the media enhanced slides of the readings section.) Students can start a lecture at any point in time, or at any of the PowerPoint slides. The lectures were recorded before an actual microeconomics class, and, through the use of multiple cameras and microphones, show instructor-student interactions and questions. The lecture slides were printed four-to-a-page, and made available to the students for purchase as a course pack at a local bookstore. (The media enhanced slides of the readings section were, for obvious reasons, not available as printed copy.) In asking the students about the order in which they used the course materials, we separated studying the lecture slides from actually watching of the lecture, and that turned out to be important. For about a quarter of the students, looking at the printed lecture slides was their introduction to a topic.

The activities include a repeatable, low-stakes, online practice quiz, and a series of individualized interactive problem sets called Problems in Microeconomics, (Brown, 2003). The problem sets are a sufficiently complex set of materials to require an extended explanation.
Each problem set consists of a one to three page explanation of the economics that forms the basis of the set. The explanation – think of it as a third, brief recap of the material in the readings section – is followed by a series of from 10 to 20 questions that are worked out using an interactive Excel-based workbook. A randomization program assures that each student gets his or her own individualized version of each problem set. (The student's ID number sets the seed in a random number generator, which in turn creates the parameters in the problem set. This allows the instructor, using the student's ID number, to generate an exact version of the student's problem, while still making it impossible for students to simply copy the answers of others. The answers are graded on the fly, with feedback, as they are entered in the answer sheet.) The students get as many attempts at each question as they want, but all answers for an entire problem set must be correct to receive credit. Answer sheets are saved as files, and submitted electronically to a secure server.

The Excel-based problem sets provide students with the chance to experiment with the main graphical templates that are so common in microeconomics texts, and to see how the economic variables and graphs respond to changes in the "givens" in a problem. The Excel-based problems are a substitute for the traditional text and lecture methods for students who like to learn through experimentation, while at the same time preferring the graphical approach to many topics. In short, the Excel-based problems offer a learning tool that caters to a very different cognitive strategy than the other tools in the course.
Answering the questions in the Excel-based problems was the one activity in the course, other than examinations, that was required and actually counted towards the students' grades.

Course communication was primarily by e-mail, though the students who were resident on campus had the opportunity to use a help room that was staffed by graduate and undergraduate teaching assistants for twenty-seven hours per week.

The students were expected to purchase the text, the printouts of the lecture slides, and the printed part of the Excel-based problems. Students with slow connections to the Internet could also purchase a CD that contained a version of the streaming video lectures. All other materials were available online through a course web site.

In summary, we provide the same subject matter in the form of traditional readings, face-to-face recorded lectures, and practice problems with the chance to experiment with economic concepts and issues.

The data

The data are from an extensive course questionnaire/evaluation form (Appendix A) administered near the end of each of the six semesters the course in which the course has been offered. The form was made available online, and the students were sent several e-mail reminders to fill out the form. The overall response rate was forty percent (N = 266), with response rates varying from 16 percent in fall 2000 to 50 percent in fall 2001.

The course evaluation questionnaire focused on three areas: student characteristics, such as class level and grade point average, how the students used the course materials, and evaluation of the materials and the course in general.
The students in the online sections closely resembled their face-to-face counterparts with two exceptions. First, we had very few freshmen enrolled. Second, there was a higher than average proportion of seniors.

Eighteen percent of the online student respondents claimed a grade point average of between 3.5 and 4.0, with eighty-five percent claiming grade point averages of 2.5 or more. Seventy-six percent of respondents said that principles of microeconomics was required for their major.

How diligent were the students in doing the course work? We asked the students to declare the number of hours per week they spent, on average, in the course. Fifty-one percent reported spending zero to three hours per week on the course. Another thirty-nine percent claimed to spend four or five hours.

At first glance, student effort appears to be paltry at best. Yet, our numbers do not seem terribly out of line with reported hours of students preparing for courses. The National Survey of Student Engagement (2003, p. 19) reports that students in business spend about 3 hours per week per course outside of class. For students in the social sciences, the time spent is about 3.4 hours per course per week. This is not very different in its degree of magnitude from our microeconomics students.

But, of course, the distinction between time spent preparing for class and time spent in class doesn't arise for an online course. While we were struck by the apparent small amount of time spent on the online course, we are not prepared to say that it is markedly different from students' efforts in their face-to-face courses.

About two-thirds of the students, sixty-six percent, ever sought help with the course materials. Students with better grades were significantly less likely to seek subject
matter help. Those who did seek help were most likely to get it by using e-mail sent to the teaching assistant in the course (thirty-four percent). Nineteen percent sent e-mail to the instructor, and twenty percent usually used the help room where face-to-face help and a number of networked computers were available. It is our impression that the help sought by the students in the online course through e-mail substituted for the in-class and after-class questioning that goes on in a traditional face-to-face course.

As instructors, we set up the course materials in the order in which we would have liked the students to use them. And this is probably the order in which we would have used them ourselves: Readings first, then lectures, and finally practice. But if we had any prior notions of what the students should have done, these were soon replaced by two facts. The first is that, when given the chance to choose, the students varied widely among themselves in how they choose to learn. The second is that, with a couple of exceptions, they chose an order for the materials that is not one we would have prescribed. This will come as no surprise to experienced online instructors (Laird, 2003).

In some cases, the students seemed to make a distinction not among our chosen categories of readings, lectures, and activities, but instead among a different set of categories that seemed to correspond to the medium of presentation. So, for example, in our "lectures" section, we included a packet of pre-printed PowerPoint slides as an aid to note-taking. But the students chose to break the intended link between the slides and the lectures, and used the printed slides as a kind of reading in terms of its medium of presentation, i.e., the printed page. This suggests to us that for some students it may be the medium in which materials are presented that is the important distinction, and not our own view of whether content is reading, lecture, or activity.
Figure 3 shows the distribution of the order in which students used the various course materials, based on questions 9 through 14 of the questionnaire.

We were, in general, struck by the differences across students in the order in which they usually used the different course materials. The distribution of when, if ever, the students used the textbook is particularly striking, being distinctly bimodal. The Mankiw text was the most popular starting point, with about 27 percent of students choosing it as the first item to work with. But it was also the least popular option, with twenty-nine percent choosing to read the book last (or not at all).
Every course resource was preferred as the first contact with the subject matter for at least some of the students. And while the students tended to use the practice quizzes last among all of the learning resources, almost twenty percent of students used the practice quiz as their first or second resource. This shows that the students did vary greatly in their cognitive strategies as revealed by their primary choices of materials.

While we assumed the lectures and their accompanying printed and on-screen slides would be used together, that was not the case for many students. In fact, the lecture slides, provided to the students as a course pack, were the first or second used resource by forty-nine percent of the students. Viewing the lectures, by contrast, was the first or second choice of only about 35 percent, and was the last choice (or never watched) for about twenty-three percent. Unfortunately, our priors on how the students would use the materials affected the survey questions. We asked the students to rank six kinds of materials by order of use, separating out "looking-at-the-lecture-slides" from the act of "watching-the-lectures" themselves. When we asked them to rank the value for learning of each kind of resource we gave them only five options, lumping together the lecture slides and viewing the lectures as one option. This was a mistake on our part. As noted above, we failed to realize that the students saw the printed lecture slides and the lectures as two distinct resources. What was an incidental resource to us, a printout of the lecture slides, became a distinctly useful resource for them that stood on its own as a valuable tool.

About half (fifty-one percent) the students tried to do the required Excel-based problem sets either first or second in their learning strategy. This popularity derives from the fact that this was one thing that had a firm due date, and really counted. We also
learned from conversations with students that their usual mode of attacking the problem sets was not to read first the printed materials and explanations of the economics that we recommended, but instead to jump right in trying to answer the questions. Only when they became stuck on a question would they go back and look for help in the problem set description. A useful analogy to help understand the students' approach would be trying to learn some branch of mathematics from a textbook by trying first to do the end-of-chapter problems without consulting the chapter.

Only six percent of the students tried the review quiz first, and most used it towards the end of their studying a topic. This was consistent with our intentions.

As Figure 3 shows, the order of using the multimedia text slides – intended as part of the readings section – was quite evenly distributed, as was viewing the lectures.

We explored whether the order in which resources are used seems to be related to other factors we can measure. It appears that students who work least hard in the course, less than three hours per week, tend to shun viewing the lectures, and put the Excel-based practice problems and practice quizzes near the top of the menu. Recall that the practice problems and practice quizzes are the two required elements in the list of learning resources.

The order in which students use the learning resources is unrelated to their grade point averages. And the grade they expect to get in the course is unrelated to the order in which they did the material.

In summary, we conclude that the students pursued diverse strategies in using the course materials. In no case did these usage patterns suggest that one or more of the resources could be dropped from the catalog of materials. If there is a lesson here, it is
that if you provide a learning resource, there are probably some students in the class who will find it accommodating to their cognitive strategies.

**What resources helped the students learn?**

Current discussions of cognitive style differences between economics instructors and their students led us to explore how useful the students found the various learning materials in the course. We assume that students will tend to use those materials that contribute to achieving course goals. The great diversity of materials available in our course allows us to explore which materials were valued by students, presumably because they found them concordant with their diverse cognitive strategies.

The survey asked the students to rate the value for learning of each of the five main categories of materials: Textbook, reading slides, the lectures, the Excel-based practice problems, and the practice quiz. With "1" being most valuable, the practice quiz was the overwhelming favorite with a mean value of 1.81. The Excel-based practice problems (2.15), lectures (2.63), and reading slides (2.72) followed in order. The textbook finished a distant last with a mean value of 3.29. Figure 4 shows the distributions of the responses.

The lecture format for teaching and learning has been subjected to much abuse. See, for example, Foreman (2003). Yet, more than a quarter of the respondents in this study gave the streaming video lectures the highest rating as a tool that contributed to learning. And more than half put the lectures in the highest or next to highest category. Clearly, the lectures were not for everyone, with thirteen percent saying they had little value. But the point is that the students were remarkably diverse in their opinions of
what seemed to work best for them, and excluding the lecture from the catalog of learning tools would have been a mistake.

Figure 4

Students' Estimates of Value for Learning of Course Materials
(1 = Highest value, ..., 5 = Lowest value.)

There is once again a great deal of variation in how students value the materials once we get past the practice quizzes and the Excel problems. We think this again reflects great diversity of cognitive strategies among students.

There seems to be no relationship between effort, measured as average work hours per week in the course, and the value of any of the materials. Hardworking
students generally do not, for example, tend to gravitate to the readings, or any other tool, as a "best" resource. So while students who put in low effort make less use of time-intensive materials such as the textbook or lectures, this low effort did not translate into a judgment about the value of those materials. This is what we would expect if effort were uncorrelated with cognitive style, but cognitive style was correlated with the values of different kinds of resources.

Nor does student grade point average seem related to the value of any of the resources. Again, this is what we would expect if grade point average was uncorrelated with cognitive style, but cognitive style was correlated with the values of the resources. On the other hand, expected grade in the course was significantly related to the value of the practice quizzes – students expecting lower grades, say 2.0 or 2.5, found the quiz significantly more valuable than students with better grades.

Assuming there is a relationship between students' cognitive styles and the choices they make about learning tools, the data on how students value the tools can be connected to the original model of cognitive styles. Table 1 shows the Spearman rank correlation coefficients for the students' valuation of each of the tools whose value is shown in Figure 4 (reading the text, reading the online PowerPoint slides, watching the lecture, doing the Excel-based practice problems, and doing the practice quiz). These correlations reveal a complex pattern of interdependencies.
Table 1 – Spearman Correlation Coefficients and (Significance Levels) for the Value of the Course Learning Tools.

<table>
<thead>
<tr>
<th>Learning tool</th>
<th>Textbook</th>
<th>PowerPoint reading</th>
<th>Lecture</th>
<th>Excel-based Practice Problems</th>
<th>Practice quiz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Textbook</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PowerPoint reading</td>
<td>−.106*</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(0.084)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lecture</td>
<td>−.198**</td>
<td>.161**</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(0.001)</td>
<td>(0.009)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excel-based Practice Problems</td>
<td>−.114*</td>
<td>.126**</td>
<td>−.109*</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>(0.065)</td>
<td>(0.040)</td>
<td>(0.077)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Practice quiz</td>
<td>.087</td>
<td>−.014</td>
<td>−.037</td>
<td>.211**</td>
<td>1.000</td>
</tr>
<tr>
<td>(0.156)</td>
<td>(0.821)</td>
<td>(0.549)</td>
<td></td>
<td>(0.001)</td>
<td></td>
</tr>
</tbody>
</table>

* Significance level between the 5 and 10 percent.
** Significance level between 0 and 5 percent.

A significant negative correlation coefficient between two tools means that students who rate one of the tools as highly valuable tend to rate the other tool at not very useful. Our interpretation in this case is that the two tools seem to appeal to students with different cognitive styles, or that they seem to represent very different ways of learning.

A significant positive correlation coefficient between two tools means that students who rate one of the tools as highly valuable tend to rate the other tool as valuable as well.

These are cases in which the tools appeal to students with similar cognitive styles. The textbook and the quiz stand uniquely alone at opposite extremes. The text has only significant negative correlations and the no significant positive correlations, so it seems to represent a unique kind of learning resource. Its value is negatively correlated with the lectures, and the Excel-based practice problems, as well as with the PowerPoint slides that are part of the readings section of the course. The practice quiz has only a single significant positive correlation with the Excel-based problems, and no significant positive
correlates. The practice quizzes and problem sets seem to complement each other, and appeal to similar cognitive styles that emphasize practice and learning by doing.

By contrast the value of the Excel-based problems is significantly correlated with all four of the other tools. Along with the positive relationship to the practice quiz, there is a positive relationship to the PowerPoint slides in the readings section of the course. The Excel problems are significantly negatively related to both the text and lecture, demonstrating the differences in the appeal of these tools. The appeal of the Excel problems to those who seem to place little value on the text and lecture is noteworthy because the Excel problems offer an option not present in the more traditional classroom that uses lecture and textbook exclusively.

The lecture's value is negatively related to that of the text, and the Excel-based problems. This suggests that the lecture appeals to different cognitive preferences than the text and problems. In addition, the value of the lecture is significantly positively correlated with the value of the reading section's PowerPoint slides. This suggests, perhaps counter intuitively, that watching the lecture and watching the animated PowerPoint slides appeals to students with similar cognitive approaches.

We note in passing that while there are many significant correlations among the values of the learning tools, the specific correlations are quite small. Even the largest correlations hover only around .20, so no tool represents anywhere near a perfect substitute for any other. Furthermore every tool has a very high value for at least some of the students. One conclusion from this is that it would be a mistake for us to completely remove any of the tools from the catalog of those available. And it might be an argument in favor of developing even more tools.
Other survey results

Generally the students thought the course presented a serious intellectual challenge, with fifty-six percent rating the challenge as high or very high. Class (freshman, sophomore, etc.) was significantly associated with the course being an intellectual challenge, with a steady progression from freshmen to seniors, who found it most challenging.

When asked if they had it to do over again, sixty-eight percent of the students said they would prefer the online option compared to face-to-face. And an overwhelming eighty-four percent said they enjoyed the class as much or more than a traditional face-to-face class. Based on their experience with this course, eighty percent of the students said they would take another online course.

While most students certainly enjoyed learning in the online format, did they think they learned as much as they would have in a face-to-face format? When asked to rate whether they learned more, as much, or less than in a face-to-face class, at least some believed they were learning less, on average. While twenty-one percent said they thought they learned more than in a face-to-face class, twenty-five percent thought they learned less. We have shown elsewhere (Brown and Liedholm, 2002) that the students were, on average, correct in their impression that they learned less. But as our 2002 study showed, the lower learning levels of online students came about principally from not learning the more complex concepts. Performance in the basic concepts was not significantly different from students in face-to-face classes.

It is worth noting that the students were also asked to state a preference over three modes of learning, not just online and face-to-face. In another question, the students
were given an additional option of learning in a hybrid course. Forty-nine percent stated a preference for the hybrid mode of instruction, which combines face-to-face and online elements.

**Lessons learned**

We present a theory of choice in which students' cognitive strategies determine the selection and use of learning tools. The theory is more general than that in the conventional learning styles literature, and suggests a broad range of student preferences among learning activities that is consistent with our data.

The innate inferiority and predicted demise of the textbook and lecture have been greatly exaggerated. Over forty percent of our students chose either the textbook or the video lecture as the starting point to study a topic. Omitting these tools from a course would be a mistake.

But students exhibited a remarkable diversity in both the order in which they used course materials, as well as the value they placed on different materials for learning. For example, while more than a quarter of students used the text first, an even larger fraction used it last or not at all. On average, working with practice quizzes emerged as the most valuable tool, but every tool was rated as having "very much" value by at least some of the students.

A student's cognitive strategy is the motivating factor in choices about learning materials. Our correlation analysis suggests that some tools, such as the practice quizzes and Excel-based problems, appeal to students with similar strategies. On the other hand, the lecture and the textbook seem to attract students with different strategies. The relationships among students' preferences for different learning tools is complex, and,
with a couple of exceptions, would not be easily predicted from mere introspection about the nature of the tools themselves.

In terms of course design, our suggestion is to include additional tools in a course, rather than look for tools to exclude. But this advice should be tempered with the knowledge that the diversity of learning strategies calls for different kinds of tools. This suggests that the future of the hybrid course is especially bright. The hybrid allows the inclusion of many more learning tools compared with the traditional course, while maintaining the comparative advantage of the lecture.
Appendix A

Course Online Questionnaire and Selected Summary Data
[N = 266. Updated 11-19-03]

Please complete the following questions about the course, teaching effectiveness, and student background.

1) Rate the instructor's teaching effectiveness.
   a. far above average. (15%)
   b. above average. (40%)
   c. average. (37%)
   d. below average. (7%)
   e. far below average. (1%)

2) Rate the overall quality of the course.
   a. far above average. (11%)
   b. above average. (36%)
   c. average. (41%)
   d. below average. (11%)
   e. far below average. (2%)

3) Was this course required in your degree program?
   a. yes. (76%)
   b. no. (24%)

4) What is your overall grade point average?
   a. less than 2.0 (2%)
   b. 2.0 – 2.5 (13%)
   c. 2.5 – 3.0 (34%)
   d. 3.0 – 3.5 (34%)
   e. 3.5 – 4.0 (18%)

5) What is your class level?
   a. freshman. (11%)
   b. sophomore. (40%)
   c. junior. (24%)
   d. senior. (23%)
   e. grad or other. (2%)

6) Are there specific things your instructor has done especially well in this course? [free text response.]

7) Are there specific things that might be improved?
8. About how many hours per week did you ordinarily spend on this course?
   a. 0 – 3. (51%)
   b. 4 or 5. (39%)
   c. 6 or 7. (9%)
   d. 8 or 9. (0%)
   e. 10 or more. (1%)

Questions 9-14. In what order did you usually perform the following course activities?
[Please type in your ranking: 1 is first, 2 is second … 6 is last.]

9. Read textbook. (mean = 3.56)
10. Review the printed PowerPoint slides for the lectures. (mean = 2.83)
11. View the lectures. (mean = 3.64)
12. Review the online PowerPoint slides (NOT the lecture slides). (mean = 3.52)
13. Do the Excel Problems in Microeconomics. (mean = 2.70)
14. Do the online practice quiz. (mean = 3.95)

15. Rate the course as an intellectual challenge.
   a. very high. (13%)
   b. high. (43%)
   c. medium. (35%)
   d. low. (5%)
   e. very low. (3%)

16. Comparing this course to other courses you have had at MSU, rate the amount of work involved in this course.
   a. much more than others. (6%)
   b. more than others. (29%)
   c. about the same as others. (49%)
   d. less than others. (11%)
   e. much less than others. (5%)

17. All thing considered, if I had it to do over again, I’d prefer to
   a. take the online (VU) version. (68%)
   b. take the traditional, classroom-based version. (32%)

18. Generally speaking, for all your courses (not just economics courses) which do you prefer?
   a. a wholly online course. (27%)
b. a partly traditional, partly online course. (49%)
c. a traditional course. (24%)

Questions 19-23. For each of the following parts of the course, evaluate how much each contributed to learning: [scale for each is: very much, much, average, little, very little]

19. Textbook (mean = 3.29; very much = 1, much = 2, etc.)
   a. very much.
   b. much.
   c. average.
   d. little.
   e. very little.

20. Online slides (not the lecture slides) (mean = 2.72)
   a. very much.
   b. much.
   c. average.
   d. little.
   e. very little.

21. Lectures with slides. (mean = 2.63)
   a. very much.
   b. much.
   c. average.
   d. little.
   e. very little.

22. Excel Problems in Microeconomics (mean = 2.15)
   a. very much.
   b. much.
   c. average.
   d. little.
   e. very little.

23. Practice quizzes. (mean = 1.81)
   a. very much.
   b. much.
   c. average.
   d. little.
   e. very little.

24. At any time in the course did you seek help with the subject matter?
   a. yes. (66%)
   b. no. (34%)

25. If you did seek help with the subject matter, which method did you use most?
26. Based on your experiences in this course would you take another online course at MSU?
   a. yes. (80%)
   b. no. (20%)

27. At any time did you seek help with using the technology?
   a. yes. (32%)
   b. no. (68%)

28. I think the web was used in effective ways to assist learning?
   a. strongly agree. (34%)
   b. agree. (44%)
   c. neutral. (17%)
   d. disagree. (3%)
   e. strongly disagree. (1%)

29. What surprised you (if anything) about taking this virtual university course? [free response text]

30. I have learned ____________ in this class than I would have in a traditional class.
   a. more. (21%)
   b. as much. (53%)
   c. less. (25%)

31. I enjoyed this web class __________ I would have enjoyed it if it had been offered as a traditional course.
   a. more than. (59%)
   b. as much as. (25%)
   c. less than. (16%)

32. Where did you usually go to access the virtual university course?
   a. home computer. (76%)
   b. MSU (East Lansing) lab. (19%)
   c. MSU distant lab (not East Lansing campus). (0%)
   d. other lab. (1%)
   e. work computer. (4%)

33. What suggestions do you have to improve this particular course? [free response text]
34. What suggestions do you have for offering virtual university courses in general? [free response text]

35. Please indicate what grade you think you will get in the course based on the work you have done so far, including exam scores and problem set. [N = 176]
   a. 4.0 (20%)
   b. 3.5 (21%)
   c. 3.0 (34%)
   d. 2.5 (13%)
   e. 2.0 (10%)
   f. less than 2.0. (2%)
References


Footnotes

1 Hybrid courses are a blending of the face-to-face and completely online formats. The distinguishing feature of a hybrid course is that it reduces the number of face-to-face contact hours. Completely face-to-face courses may use online materials or communication tools, but continue to meet for the full number of "contact" hours for the course. An online course has no face-to-face instruction, but may use the face-to-face setting for assessment.

2 Our use of the term cognitive style is meant to distinguish our notion of learning preferences and choices from the notion of learning styles associated with Kolb (1984), and Felder and Silverman (1988). For an excellent discussion of the role of learning styles in teaching see Brophy (1998, pp. 226-41), and Good and Brophy (1995, pp. 526-535). The key idea in the learning styles literature is that students have possibly diverse learning styles that make it easier for them to learn using some learning tools than others. Where Brophy, and Good and Brophy seem to part company with the rest, correctly we believe, is that they do not think that learning styles can be usefully defined on the basis of a short psychological test, the results of which are used to group students into one of a small number of distinct learning styles. For example, Felder and Silverman (1988) define eight learning style categories. For an example of a course that has different "tracks" for students with different learning styles see Acker, et al. (2003).

While we accept the premise of the learning styles literature that some students learn more efficiently using some learning tools and techniques compared to others, reducing the allowable combinations to a small number leads to oversimplification and questionable policy recommendations. It is as if economists were to suggest that a person's preferences over a large number of goods and services could be reduced to a small number of types, with one type being dominant. This line of reasoning might lead, for example, to some people having "ice cream" preferences, and others as having "potatoes" preferences, and then designing consumption bundles to satisfy those preferences. This may seem bizarre, but it is just what some writers suggest when they design completely different versions of a course based on learning styles questionnaires given to students.

Our preference is to define a student's cognitive style over all of the possible tools, and to suggest that the student then make choices among the tools, and how much to use them, to achieve learning objectives. Our approach rejects the classifications of learning styles that too often read like horoscopes for students.

3 See, for example, Mankiw (2002), pp. 45-57.