

**Integration of Pop-up Text Into a Humphrey Visual Field  
Printout For Use By Students On WebCT**

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## **Introduction**

Active learning is very important and can complement passive learning from lectures. Students learn at their own pace and through various methods. With advancements in computers and graphical interface, there is a vast untapped potential for an interactive self-paced learning environment. The goal of this project is to explore various techniques for adding pop-up text to a Humphrey visual field printout. This includes optimal resolution and size needed for display on a computer monitor with minimal scrolling and maximum readability. This file must then be incorporated into WebCT for use by students in the visual fields class.

## **Feasibility Analysis**

This project seemed very feasible. Examples of pop-up text were seen on various internet sites. Resolution of scanners has also improved to the point that fine details from a visual field were easily displayed on a monitor if a quality original copy was obtained. Html files were easily be integrated with WebCT.

## **Development**

The first step in development required scanning of a visual field with sufficient detail to be read on a 15-inch standard monitor. Various settings were explored within the scanning software. Optimal scanning can vary with scanning software and scanners used but color scanning with the highest resolution setting provided optimal readability. The size of this bitmap file is not important since it is not needed once a jpg file is made. Next, the bitmap file was resized to provide optimal readability with minimal scrolling. Scanning at 100 dpi is adequate for readability and requires no resizing when in Paint Shop Pro 7. Many trials were performed. Due

to the 8- inch width and 10-inch length of a visual field, some vertical scrolling was needed for all text to be readable on a 15-inch monitor. The Optimal size was originally modified within the scanning software. With PSP, the bitmap can be cropped (borders trimmed) and easily resized. For an 8-inch X 10-inch visual field print out, resizing to 30% of the original 1200 dpi scanned size was optimal.

The pop-up text must be within an html file that will function on WebCT. This file can be accessed from any computer with no installation of software needed.

Editing html code was the first option considered. This requires precise coordinates of the “hot spot” area or graphic that will activate pop-up text during mouseover or other activation techniques. I consulted with Douglas Fonner, Ph.D., Professor, College of Arts and Sciences, involving a small mapping program that he found on the internet and modified for his needs. This process involved many steps. First, the field was scanned with scanning software. The file was then converted to a \*.jpg file. A base html file was made with the mapping program. This program mapped out precise coordinates of each “hot spot” area on the field that requires an explanation in pop-up text. The pop-up text was carefully edited into the code of individual html files and saved. The base html file was carefully edited with the individual pop-up text file names that correspond with the mapped areas. After many trials, this process was successfully performed in a working state on WebCT. A major difficulty encountered involved the edited syntax in the base html file. The file name included a directory location from the base computer that was not present on WebCT. Deleting all directories and drive designations solved this

problem. The corresponding pop-up text html files must be included within the same folder as the base html file on WebCT.

An easier method was desired to make this teaching aid useful to those who are not comfortable editing html code. Paint Shop Pro 7 (PSP) was discovered to have a pop-up text creator, html mapping, graphics editing, and many other web features. Many difficulties were encountered when trying to obtain the Paint Shop Pro 7 software for use at Michigan College of Optometry. A site license for Ferris State University with up to seven active computer installations of the software was determined to be the most economical and preferred method. However, this method was not practical for use by a fourth year student when off campus. This software could only be installed on school computers. I then decided to download a 30-day free trial of the software from the Jasc.com web site. I later purchased a copy of the software to avoid restrictions of the site license and computer lab hours. With PSP, a scanned bitmap file can be edited and resized as desired then converted to a jpg. An html file can also be made within PSP with mapped coordinates and pop-up text. The jpg, html, and PSP mapping file (\*.jmd) must then be uploaded into the same directory within WebCT. The html file will then work in this form on WebCT with some limitations. The pop-up text will not function within a Netscape browser. Only Internet Explorer can be used with the unmodified PSP html file. In addition, mapped pop-up text will not activate when scrolling beyond the initial html display with 0,0 (X,Y) at the upper left corner of the screen. Many trials were needed to pinpoint these exact limitations. Due to the vertical scrolling needed for visual field printouts, the pop-up text concept was abandoned in favor of permanently displayed text that was edited onto the jpg file directly in PSP. An html file was then saved which also included this added text. Many

examples of visual fields from class were made in html form within WebCT for student to use online in the future.

### **Examples**

Examples are included of sample visual fields and the html code for each of the three techniques used. The first example includes html code for the base file and three individual pop-up text files. The text from each pop-up file is also included. An example of pop-up text made with PSP is included next. Finally, a simple html file, with PSP edited text and drawn figures, is provided.

### **Conclusion**

An increased availability of printouts online for students to practice should improve interpretive skills and provide examples of defects from real patients for those students in visual field class. This provides interactive learning with unlimited repetition available at the student's discretion. Students can learn at their own pace and set their own hours for study. These graphical modification techniques can be used by other educators interested in providing online self-study with WebCT. Future development can be made with use of PSP7. Many options are available for activating pop-up text including: mouseover, double click, single click, and right click. Avoiding the combination of both scrolling of the final image and pop-up text is recommended.

### **References**

1. <http://gocertify.com/article/cbt.shtml>
2. <http://www.imet-memphis.net/spiceland1.pdf>
3. <http://www.psrc-online.org/classrooms/papers/sokoloff.html>
4. <http://www.usdoj.gov/adr/workplace/pdf/wp-reten.pdf>

Base file html code for Field1

```

                                Field1
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.0 Transitional//EN">
<HTML><HEAD><TITLE>Field1</TITLE>
<META content="text/html; charset=windows-1252" http-equiv=Content-Types>
<SCRIPT language=JavaScript>
var explainWin = null
var file = null

function change(n){

    if (n==1){file='file1.html'}
    if (n==2){file='file2.html'}
    if (n==3){file='file3.html'}
    if (n==4){file='file4.html'}

    if (!explainWin || explainWin.closed){
        explainWin = window.open(file,'explainWin','width=320,
height=240,toolbar=1,location=0,directories=0,status=0,menuBar=0,scrollBars=1,resizable=1');
        explainWin.focus();
    }

    else {
        explainWin.open(file,'explainWin','width=320,height=240,toolbar=1,location=0,directories=0,status=0,menuBar=0,scrollBars=1,resizable=1');
        explainWin.focus()
    }
}

</SCRIPT>

<META content="MSHTML 5.00.2314.1000" name=GENERATOR></HEAD>
<BODY bgColor=#ffffff>
<SCRIPT>

/*
Text Link/Image Map Tooltip Script-
© Dynamic Drive (www.dynamicdrive.com)
For full source code, installation instructions,
100 's more DHTML scripts, and Terms Of
Use, visit dynamicdrive.com
*/

if (!document.layers&&!document.all)
event="test"
function showtip(current,e,text){
if (document.all){

```

## Field1

```
thetitle=text.split('<br>')
if (thetitle.length>1){
thetitles=''
for (i=0;i<thetitle.length;i++)
thetitles+=thetitle[i]
current.title=thetitles
}
else
current.title=text
}
else if (document.layers){
document.tooltip.document.write('<layer bgColor="white" style="border:
1px solid black;font-size:12px;">'+text+'</layer>')
document.tooltip.document.close()
document.tooltip.left=e.pageX+5
document.tooltip.top=e.pageY+5
document.tooltip.visibility="show"
}
}
function hidetip(){
if (document.layers)
document.tooltip.visibility="hidden"
}
</SCRIPT>

<DIV id=tooltip style="POSITION: absolute; VISIBILITY: hidden"></DIV><
FONT
color=#000000><FONT face=Arial>
<H3 align=center>Field1 </H3>
<CENTER><IMG src="Field1_files/f2.gif" useMap=#map1></CENTER><MAP
name=map1><AREA coords=53,37,167,53 href="javascript:change('4')"
onmouseout=hidetip() onmouseover="showtip(this,event,'Test Parameter
s')"
shape=RECT><AREA coords=50,78,98,124 href="javascript:change('3')"
onmouseout=hidetip()
onmouseover="showtip(this,event,'Test Reliability Indices')" shape=R
ECT><AREA
coords=186,28,307,38 href="javascript:change('2')" onmouseout=hideti
p()
onmouseover="showtip(this,event,'Patient Information')" shape=RECT><
AREA
coords=204,59,320,149 href="javascript:change('1')" onmouseout=hideti
p()
onmouseover="showtip(this,event,'Gray Scale Format')"
shape=RECT></MAP><BR><BR><FONT
size=-1><!--CAPTION--><!--ENDCAPTION--></FONT></FONT></FONT></BODY></H
TML>
```



Printout of the base file (Field1)



Pop-up text file html code for File1

file1

```
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 3.2 Final//EN">
```

```
<HTML>
```

```
<HEAD>
```

```
<TITLE>Untitled</TITLE>
```

```
</HEAD>
```

```
<BODY>
```

```
This is the grayscale.
```

```
</BODY>
```

```
</HTML>
```

Example of pop-up text for File1

This is the grayscale.

Pop-up text file html code for File2

file2

```
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 3.2 Final//EN">
```

```
<HTML>
```

```
<HEAD>
```

```
<TITLE>Untitled</TITLE>
```

```
</HEAD>
```

```
<BODY>
```

The birthdate is important for trial lens calculations.

```
</BODY>
```

```
</HTML>
```



Example of pop-up text for File2

The birthdate is important for trial lens calculations.

Pop-up text file html code for File3

file3

<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 3.2 Final//EN">

<HTML>

<HEAD>

<TITLE>Untitled</TITLE>

</HEAD>

<BODY>

The fixation losses value is an indication of how well the patient fixates, and the lower it is, the more confidence one can have in the test results.

A false positive error is recorded if the patient responds when no stimulus is present.

A false negative error is recorded if the patient does not respond to a stimulus which is much brighter than threshold in an area where sensitivity has already been determined.

</BODY>

</HTML>

Example of pop-up text for File3

The fixation losses value is an indication of how well the patient fixates, and the lower it is, the more confidence one can have in the test results. A false positive error is recorded if the patient responds when no stimulus is present. A false negative error is recorded if the patient does not respond to a stimulus which is much brighter than threshold in an area where sensitivity has already been determined.

Pop-up text file html code for File4

**Example of pop-up text for File4**



A full threshold central 30-2 visual field with a white background was performed.

Html for PSP pop-up text for D7

d7

```
<HTML>
<HEAD>
<META NAME="Author" CONTENT="vinc6">
<META NAME="Generator" CONTENT="Jasc Paint Shop Pro 7">
<TITLE> </TITLE>
</HEAD>
<BODY>

<IMG NAME="d70" SRC="d7.jpg" WIDTH="756" HEIGHT="936" BORDER="0" USEMAP="#d7">

<MAP NAME="d7">
<AREA SHAPE="rect" COORDS="6,114,113,130" ALT="Is the patient looking
where they are supposed to be?">
<AREA SHAPE="rect" COORDS="9,128,9,131">
<AREA SHAPE="rect" COORDS="6,132,120,150" ALT="Is the patient hitting
the button when not seeing a stimulus?">
<AREA SHAPE="rect" COORDS="6,151,119,169" ALT="Is the patient not hitting
the button when they should be?">
<AREA SHAPE="rect" COORDS="5,108,161,176" ALT="Patient Reliability Parameters">
<AREA SHAPE="rect" COORDS="573,593,736,662" ALT="Global Indices - calculations
which give an overall assessment of how much the height and shape of a patient's
field of vision deviates from age-matched normals, and how consistent this patient's
responses are compared to age-matched normals.">
<AREA SHAPE="rect" COORDS="-34204,-1273871433,756,936">
<AREA SHAPE="rect" COORDS="-34204,-1273871433,756,936">
<AREA SHAPE="rect" COORDS="575,662,576,662">
<AREA SHAPE="rect" COORDS="580,603,717,623" ALT="Mean Deviation - a weighted
average of how much a patient's sensitivity differs from the age-matched normal;
an indication of how much the overall height differs from normal">
<AREA SHAPE="rect" COORDS="583,625,717,640" ALT="Pattern Standard Deviation -
a measure of the degree that the patient's field exhibits localized defects rather
than generalized defects; and indication of how much the shape differs from normal">
</MAP>

</BODY>
</HTML>
```

Example field from D7

**SINGLE FIELD ANALYSIS**

EYE:

NAME:

ID:

DOB:

**CENTRAL 24-2 THRESHOLD TEST**

FIXATION MONITOR: GAZE/BLINDSPOT

STIMULUS: III- WHITE

PUPIL DIAMETER: 4.7 MM

DATE

FIXATION TARGET: CENTRAL

BACKGROUND: 31.5 ASB

VISUAL ACUITY:

TIME

FIXATION LOSSES: 0/17

STRATEGY: SITA-STANDARD

RH: +0.00 DS UC X

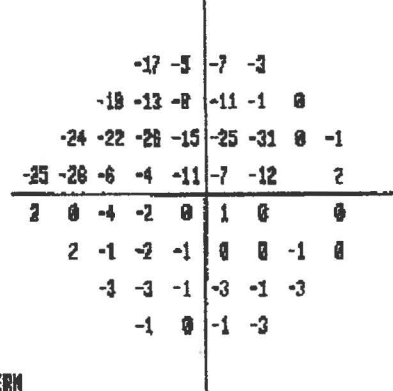
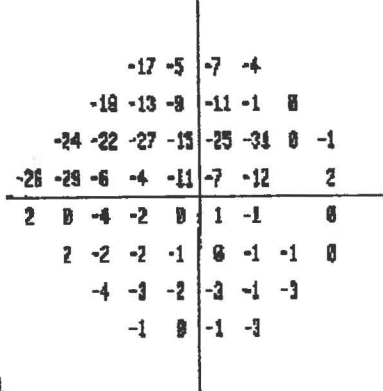
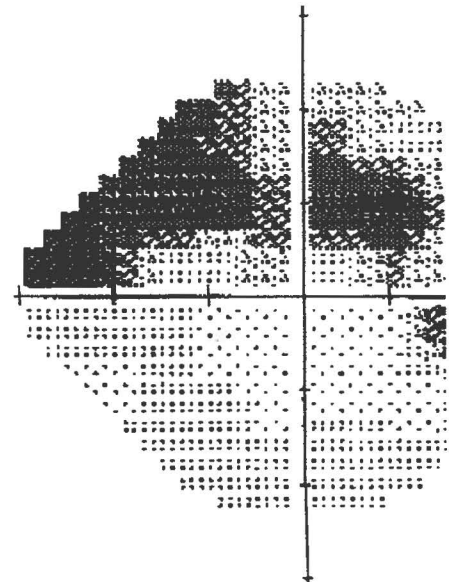
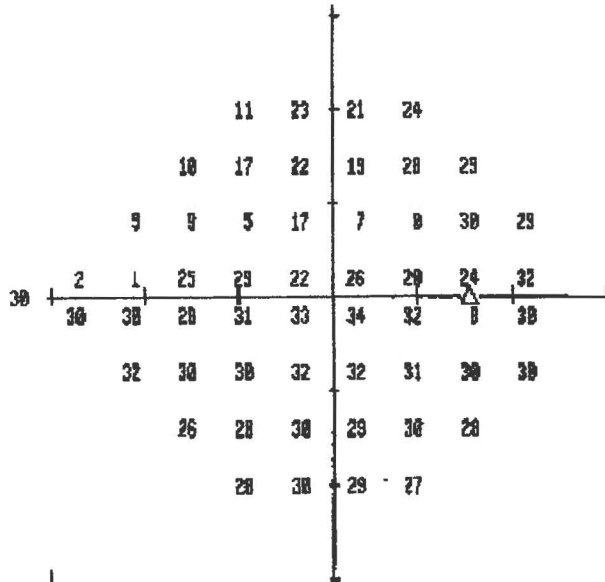
AGE:

FALSE POS ERRORS: 0 %

FALSE NEG ERRORS: 0 %

TEST DURATION: 06:59

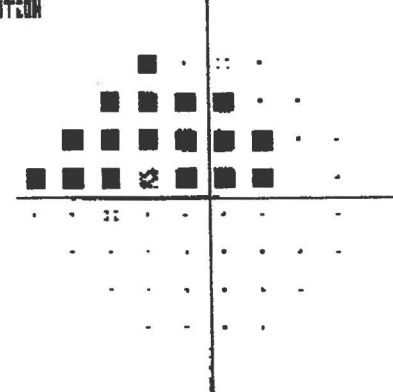
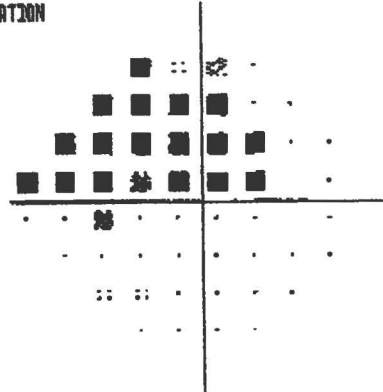
FOVEA: OFF



GHT  
OUTSIDE NORMAL LI  
  
MD -8.69 DE  
PSD 9.50 DE

TOTAL DEVIATION

PATTERN DEVIATION



11 P ( 5%  
12 P ( 2%  
30 P ( 1%

FSU COLLEGE OF OPTOM  
131B Cramer Circle  
RTE 60PT06, NY 14907

Html for PSP simple edited text file tl

t1

```
<HTML>
<HEAD>
<META NAME="Author" CONTENT="vinc6">
<META NAME="Generator" CONTENT="Jasc Paint Shop Pro 7">
<TITLE> </TITLE>
</HEAD>
<BODY>

<IMG NAME="t10" SRC="t1.jpg" WIDTH="678" HEIGHT="729" BORDER="0" USEMAP="#t1">

<MAP NAME="t1">
</MAP>

</BODY>
</HTML>
```

Example field from tl

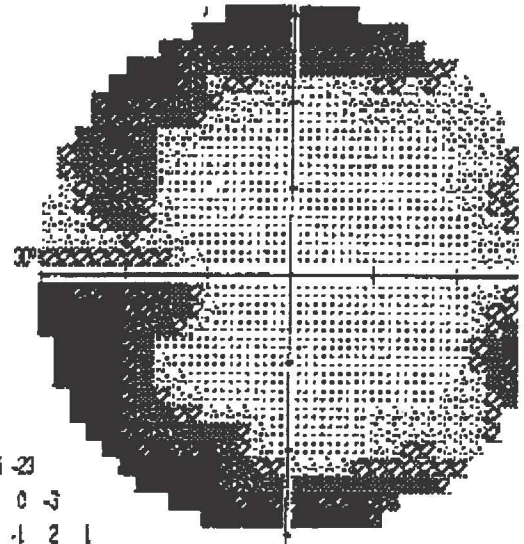
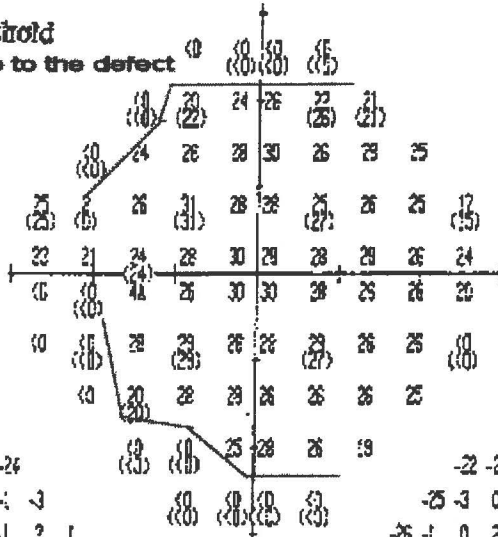


# Central 30-2 Threshold

notice the shape and location of this defect which is likely due to a trial lens problem

Strategy: Full Threshold  
note the steep edge to the defect

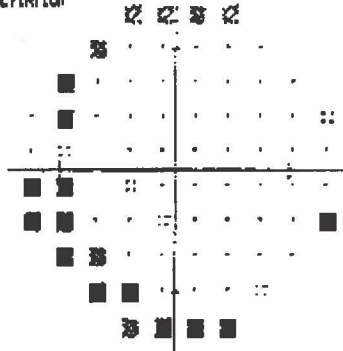
LEFT  
AGE 71  
FIXATION LOSSES 3/50  
FALSE POS ERRORS 0/10  
FALSE NEG ERRORS 0/16  
QUESTIONS ASKED 529  
TEST TIME 00:15:10  
HFA 9/4



A

	-22	-22	-24	-24
	-25	-3	0	-1
	-27	-1	0	1
0	-25	-1	0	-1
-1	-7	-1	-1	-1
-29	-30	-4	-4	-5
-25	-30	-1	-1	-25
-25	-3	-1	-1	-1
-25	-30	-3	-1	-7

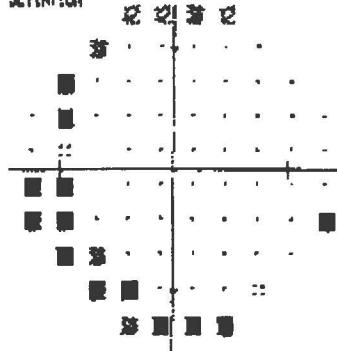
TOTAL  
DEVIATION



PROBABILITY SYMBOLS  
● P < 3%  
■ P < 2%  
■ P < 1%  
■ P < 0.5%

	-22	-22	-24	-23
	-25	-3	0	-3
	-26	-1	0	2
0	-25	-1	0	-1
-3	-3	-1	0	0
-25	-30	-4	-1	-5
-28	-30	0	-4	-26
-28	-3	-1	-1	0
-28	-30	-3	-1	-5

PATTERN  
DEVIATION



GLAUCOMA HEMIFIELD TEST (GHT)  
OUTSIDE NORMAL LIMITS

MD -5.97 DB P < 1%  
PSD 10.98 DB P < 0.5%  
SF OFF  
CPSD OFF

## References

# Computer Based Training Provides Active Learning

*Self-paced and readily available, CBT is a powerful certification preparation tool.*

**By Anne Martinez**

**Page 1 of 3   1 2 3**

Internet.com's Webopedia defines computer-based training (CBT) as a type of education in a which the student learns by executing special training programs on a computer. This definition worked fine before the Internet came into such widespread use, but now there are so many different ways to use computers to learn that the lexicon has been forced to expand.

Web-based training, for example, is a subset of computer-based training - basically it's a method of taking CBT and applying Internet/Web technologies. Doing so enables more current content, computer platform independence, and wider distribution, but has its own restrictions due to connection speed and bandwidth. Lately an umbrella term, which encompasses all of these different formats of computer delivered training, has appeared: Technology Based Training (TBT). The CBT we're focusing on in this article takes the format of tutorials and coursework delivered via CD ROM or Web.

## **Best Features**

CBT has a number of things going for it as a certification training tool, borrowing some features from both self-study and instructor led learning. First, because it appeals to multiple senses - seeing, hearing, and doing - CBT is good for people with various learning styles. Plus, receiving information through more than one sense increases the likelihood that you will be able to recall it in the future.

Good CBT programs are an active rather than passive form of study. Instead of sitting motionless scrutinizing page after page of text, you get to perform tasks and answer questions. You also proceed at your own pace instead of being governed by a rate imposed by an instructor or fellow students. If you need to interrupt a lesson in the middle, no problem-you can pick up where you left off later, without having missed anything. Already have adding new users to the system down cold? Skip right past it. Didn't quite get that subnetting bit? Go back over it again, and again, until it sinks in.

Unlike classroom learning, CBT courses you purchase can be kept on hand as reference resources, just like books. And although not quite as portable as a book, you can usually transfer the software from one computer to another, or use it on your laptop as long as you have a CD-ROM drive available. Courseware is usually less expensive and more convenient than classroom learning, providing a combination of time and money savings that is hard to beat.

**Few Drawbacks**

Despite all the positive features CBT has to offer, it's not without drawbacks. Perhaps the most off-putting to the IT professional is that it involves more staring at the computer, something most of us already spend a good bit of the day doing. Many people choose a different format for their studying, just because, well, it's different. And although it's perhaps more engaging than a book, as with all forms of self-study, learning via CBT requires a substantial amount of self-discipline and internal motivation. You won't be provided with specific class times, dates, and deadlines, but will have to create them for yourself.

Although it's become much less common than when CBT was new, occasional technical difficulties still happen. It can be really frustrating when you're sitting down, all psyched up to learn, and your computer speakers remain silent or the screen freezes up. This particular problem can be largely avoided with a little advance planning. Stick to established CBT vendors and take care to determine system requirements in advance and make sure your setup meets or exceeds them.

### **Knowledge Focused or Task-Oriented**

CBT courses typically falls into one of two categories: knowledge-focused or task-oriented. Task oriented programs walk you step-by-step through particular procedures. Often they will include screen shots or even simulations of the environment you are studying. You'll be instructed on how to complete a particular task, and then the quizzed on what you have learned, or asked to repeat the steps yourself using a simulated interface. CBT programs that include simulations are especially useful as they make it possible to practice in environment that mimics the real one, without having to go to the expense of purchasing and installing it, or assuming the risk of practicing on someone else's live system. The majority of CBT programs are task oriented.

Knowledge-focused CBTs work a bit differently. Instead of being presented the specific steps needed to perform individual tasks, you'll face a more open-ended environment. Programs in this category rarely include interface simulations, but rather focus on the what and why instead of how. They are primarily used to convey theory and background knowledge if a specific technology. For example, a knowledge-focused course is more likely to cover a topic like client/server computing rather than the ins and outs of a particular operating system. Learning Tree International makes impressive use of this style for some of its courses.

### **Do the Demos**

The prices of CBT programs vary widely. They're influenced by the complexity and depth of the material covered, popularity of the subject matter, and degree of development that went into creating the product. For example, a seven course complete A+ curriculum from NETg runs \$499.65 when purchased online. ComputerPrep sells a single Network+ course on CD-ROM, geared for experienced networking professionals , for \$100. So you're going to have to shop with care to get the right materials for you, at a good price.

The best way to shop for CBT is online. That's because most CBT vendors have demos available for you to sample, freely accessible from the vendor's Web site. Take the time to try some of them out, even if the vendor comes recommended by a colleague. Start by assessing the interface. Watch out for CBT that is just blocks of text on the screen—programs like this are not making good use of available technology and will be less valuable learning tools. Does it make you click after every sentence or proceed forward automatically with minimal intervention from you? Can you jump forward and backward through the lessons as needed? Does it

remember where you left off and restart there automatically?

If the interface passes muster, move on to the content issues. Will the courseware you'll be purchasing cover all the material you need to know to pass the certification exam? Was it created by qualified instructors? Is it at the proper level for your current expertise? Slogging through networking basics when you already have been working in the field for years is a tedious waste of time. How many parts is the course broken into (that you'll have to purchase)? Sometimes one course appears dramatically cheaper than another, but closer inspection reveals that the less expensive one only covers part of the material.

Some courses offer pre and post course assessments. These are intended to help you (or your manager) gauge your improvement, as well as to identify areas of strength and weakness. Although not a critical feature to many students, some find it a valuable addition. But whether or not the software offers such assessments, it should provide feedback on your progress. A few quizzes thrown in at the end of each section will keep you honest and help you verify that you're really learning.

Finally, make sure that the software is compatible with your computer. This is much less likely to be an issue than when CBT was new, but take time to assure that you're purchasing the right version for your computing environment.

It's amazing how CBT has progressed from the first, achingly slow CD-ROM to robust programs that incorporate audio, video, and hands-on activities to reinforce learning and make even the driest of material more palatable. We're coming very close to certification training whenever and wherever you want it. How long can it be before the Internet appliances that are beginning to appear in cars will bring you CBT on wheels? Then again, Certification Roving Automobile Study Helpware (CRASH) is an innovation we can probably do without for a wee bit longer.

###

#### Resource:

Here is a sampling of the many companies eager to train you via CBT, along with a few extra resources to help you connect up with the software that can help you get certified...

ComputerPREP (now part of ProsoftTraining.com)  
CompTIA, Microsoft, Cisco, CIW

Coriolis (Personal Trainer products)  
Cisco, CompTIA, Microsoft

KnowledgeNet  
Cisco, CompTIA, Microsoft

LearnKey  
Cisco, CompTIA, Lotus, Microsoft, Novell

NETg  
Cisco, CompTIA, IBM, Microsoft, Novell, Oracle, general technology topics

Specialized Solutions  
CompTIA, Microsoft, Novell

Yahoo!'s index of CBT certification training vendors

# THE IMPACT ON LEARNING OF ALTERNATIVE STUDENT-TEACHER COMMUNICATION TECHNIQUES

J. David Spiceland, University of Memphis

Charlene P. Hawkins, University of Memphis

(research in progress)

## Abstract

More sophisticated and affordable technology has motivated many universities and colleges to offer a variety of alternatives to traditional classroom instruction. These alternatives include distance education courses via television at remote classroom sites and both synchronous and asynchronous internet courses. The least traditional of these alternatives utilizes asynchronous communication by which communication is mediated by technology and is not dependent on teachers and students being present in the same location at the same time. By using asynchronous communication, students can work at their own pace and at locations they are able to control (Berge, 1999; Edelson, 1998). Many of the traditional classroom activities can be recreated technologically through computer conferencing, electronic mail, bulletin boards, and the internet. In fact, the use of the internet to deliver distance education has grown faster than any other instructional technology (Stringer, 1998).

There are many differences between asynchronous interactions and traditional classroom communication, but the most critical differences involve those that may affect a student's capacity to learn (Winiecki, 1998). In a regular college course there is unity of space, time, and sequential actions. A distance education class lacks all of these (Edelson, 1998). Many educators worry that without classroom discussion and student interaction, instructors cannot provide real guidance and feedback (Jaffe, 1997; Edelson, 1998). Questions related to the effectiveness of technology-based courses in facilitating instructional tasks pose significant concerns for all educators involved in or contemplating conducting such courses (Wegner, 1999).

Answers to these questions should depend on the extent to which technology is used to mediate classroom instruction. In an internet-based, paperless course, the student must be an active learner. In contrast with the passive learner who sits in a classroom and receives information orally, the active learner must aggressively seek and assimilate packets of knowledge to achieve the core competencies identified in the course. The purpose of this study is to explore the impact on learning of asynchronous internet courses as compared to traditional classroom learning. Specifically, the study examines student perceptions of the effectiveness of an active-learning, asynchronous internet course relative to that of a traditional classroom-based course. Students are asked to compare effectiveness on a variety of dimensions.

The study yielded results consistent with previous research related to learning outcomes, in particular, that of Sandercock (1999). Specifically, students indicated the use of the online course had helped them gain new skills as compared to the traditional classroom setting (mean of 3.87). Similarly, most students responded positively concerning whether they would take another online computer-assisted course. This is consistent with several studies (Soo, 1998; Stringer, 1998; Sandercock, 1999; Wegner, 1999) that indicate students have more positive attitudes about their learning in an online course. Since the population of the study consisted of graduate students familiar with computer technology, these results also are consistent with



previous research in which students with a greater understanding of online communication (Irani, 1998) and more cognitively mature graduate students (Larison, 1997) were more comfortable with and performed better in distance learning courses. Results, though were somewhat inconsistent with previous research (Rountree, 1996; Irani, 1998; Wegner, 1999) that indicated no significant difference in learning performance. Students responded positively to the question concerning the use of the internet as an effective learning tool.

Students had a relatively less favorable response when comparing their ability to learn the material in the online computer course to their ability to learn the material in the traditional classroom setting. Responses related to students' motivation to complete the assignments in the online computer course also were not as convincingly positive. In the online computer course, these two learning outcomes involve active learning as compared to a more common use of passive learning in the traditional classroom. Since active learning involves more time, energy, and self-reliance, the response could be the result of the difficulty adapting to this kind of learning involved rather than the medium used.

Concerning communication effectiveness, results indicated that students felt that e-mail is an effective means of communicating with the instructor. Students also had a positive response to the Bulletin Board for communicating. However, students were less favorable toward their ability to discern course objectives as compared to the traditional classroom setting. This might be due to the fact that course objectives are relatively easy to relate in either learning format.

In conclusion, the findings of this study are in general agreement with earlier research indicating that students have a more positive attitude about the course and their learning in an online computer course. It offers new evidence as well that learning can be enhanced with an active learning format in an online course. It is possible that the favorable attitudes of students surveyed toward their online learning experience were in part due to this being their first exposure to a course of this type. Whether incremental benefit persists beyond a single course is not answered by this study. Additional research is necessary to determine whether most or all of the benefit is gained with one course or whether second and subsequent course, similarly structured, would be viewed as favorably, or even more favorably, than the first such course.

# USING INTERACTIVE LECTURE DEMONSTRATIONS TO CREATE AN ACTIVE LEARNING ENVIRONMENT

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This paper reports on a general strategy for making the learning environment in large (and small) lectures more effective by increasing student involvement. We have used and evaluated the effectiveness of Microcomputer-Based Interactive Lecture Demonstrations (ILDs) in introductory physics lectures since 1989 and have found them to be very successful for teaching physical concepts. The ILDs consist of a sequence of conceptually simple physical experiments using the Tools for Scientific Thinking microcomputer-based laboratory (MBL) tools. Students are actively engaged by the use of a learning cycle which includes a written prediction of the results of an actual physical experiment, small group discussion with their nearest neighbors, observation of the physical event in real time with the MBL tools, and comparison of observations with predictions. The development of this strategy has been based on the outcomes of physics education research and on our experiences with guided discovery laboratory curricula using MBL tools. In this paper the general ILD procedure is described and specific examples of ILDs which enhance learning of kinematics and Newton's Laws are presented. Research on the effectiveness of this strategy using the research-based Force and Motion Conceptual Evaluation is presented. There is strong evidence for significantly improved learning and retention of fundamental concepts by students who participate in ILDs as compared to those taught in traditional lectures.

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## INTRODUCTION

A major focus of the work at the Center for Science and Mathematics Teaching (CSMT) at Tufts University has been on active, discovery-based laboratory curricula supported by real-time microcomputer-based laboratory (MBL) tools. With these tools and curricula, it has been possible to bring about significant changes in the laboratory learning environment at a large number of universities, colleges and high schools without changing the lecture/laboratory structure and the traditional nature of lecture instruction (1-5). One of these curricula, RealTime Physics, is discussed in a companion paper in this publication (1).

Despite considerable evidence that traditional approaches are ineffective in teaching these concepts (1-6), most physics students in the United States continue to be taught in

lectures, often in large lectures with more than 100 students. Also, while effective MBL laboratory curricula like Tools for Scientific Thinking (7) and RealTime Physics (8) have been developed, many high school and college physics programs have only a few computers and are unable to support hands-on laboratory work for large numbers of students. Over the past six years we have worked at creating successful active learning environments (like those associated with our laboratory curricula) in large (or small) lecture classes primarily at the University of Oregon and at Tufts University. The result of these investigations has been the development of a teaching and learning strategy called Tools for Scientific Thinking Microcomputer-Based Interactive Lecture Demonstrations (ILDs).

This paper will first discuss the general ILD procedure and guidelines for creating effective ILDs. We will show actual examples of ILD sequences for teaching kinematics and dynamics. Finally, we will present research results which make use of the Force and Motion Conceptual Evaluation (1,3,5) to assess student conceptual learning gains as a result of the ILDs, and compare these results with learning gains as a result of traditional instruction.

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## THE INTERACTIVE LECTURE DEMONSTRATION PROCEDURE

In 1989 at the University of Oregon, encouraged by our successes in fostering conceptual learning in the introductory physics laboratory (1-5) we began to explore strategies for using Microcomputer-Based Laboratory (MBL) tools to establish an active learning environment in the lecture portion of the introductory course. After several years of research, we formalized in 1991 a procedure for ILDs which engages students in the learning process and, therefore, converts the usually passive lecture environment to a more active one. The steps of the procedure are:

1. The instructor describes the demonstration and does it for the class without MBL measurements.
2. The students record their individual predictions on a Prediction Sheet, which will be collected, and which can be identified by each student's name written at the top. (The students are assured that these predictions will not be graded, although some course credit is usually awarded for attendance at these ILD sessions.)
3. The students engage in small group discussions with their one or two nearest neighbors.
4. The students record their final predictions on the Prediction Sheet.
5. The instructor carries out the demonstration with MBL measurements displayed on a suitable display (multiple monitors, LCD, or computer projector).
6. A few students describe the results and discuss them in the context of the demonstration. Students fill out a Results Sheet, identical to the Prediction Sheet, which they may take with them for further study.
7. The instructor discusses analogous physical situation(s) with different "surface"

features. (That is, different physical situation(s) based on the same concept(s).)

These steps are performed for each of the simple demonstrations in the sequence making up an Interactive Lecture Demonstration.

Student involvement in understanding these simple conceptual demonstrations is obvious from observing students in the classroom. The instructor must use her/his judgment in controlling the amount of time devoted to steps 2 and 3. The small group discussions in a large lecture class are initially quite animated and “on task.” In time, however, the discussions may begin to stray into extraneous matters, at which point it is time to move on to steps 4 and 5. The instructor must also have a definite “agenda” for steps 6 and 7, and must often use guidance to move the discussion towards the important points raised by the individual ILDs.

Several other researchers have used a similar procedure to engage their students during lectures. While a few have used actual lecture demonstrations with real data displayed using MBL tools (9), most of these have not involved physical experiments but rather student reasoning or problem solving. A number of these other strategies involve the use of a student response system which collects individual student responses and feeds them into a computer system for display to the instructor and, if desired, to the class. For example, Mazur (10) has reported on his use of such a system in introductory physics lectures at Harvard University. His students are led to conclusions based primarily on reasoning processes, rather than on observations of physical phenomena. Others have made use of a similar student response strategy (11, 12).

As we have said the ILDs are a series of short, simple experiments. We have used two basic guidelines in designing experiments for ILD sequences. First, the order and content of the sequences are based on the results of research in physics learning, and on our experience with student learning in hands-on guided discovery laboratories. The sequences must start with what the students know and lay the basis for additional understanding if they are to be successful. Secondly, the ILDs must be presented in a manner such that students understand the experiments and “trust” the apparatus and measurement devices used. Many traditional exciting and flashy demonstrations are too complex to be effective learning experiences for students in the introductory class. The real time display gives students feedback in a way that builds confidence in the measurement devices and the resulting data.

Our experiences in developing laboratory curricula and evaluating the learning results (1-5,7,8) have been invaluable in selecting simple but fundamental lecture demonstrations. For example, in kinematics and dynamics we start with the most basic demonstrations to convince the students that the motion detector measures motion and the force probe measures force in an understandable way. These very basic demonstrations also begin to solidify student understanding, before moving on to more complex and concept-rich demonstrations.

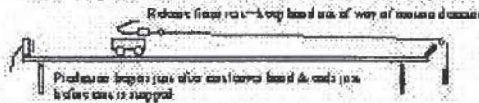
Table 1. Mechanics Interactive Lecture Demonstration Sequences

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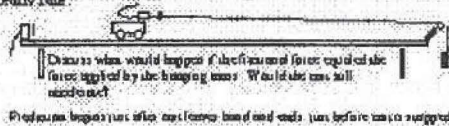
ILD Sequence	Contents
Kinematics 1: Human Motion	Introductory, constant velocity kinematics using a motion detector to explore walking motions. Relationships between distance-(position-) and velocity-time graphs.
Kinematics 2: Motion with Carts	Kinematics of constant velocity and uniformly accelerated motion using the motion detector to display the motion of a low-friction cart <sup>3</sup> pushed along by a fan unit (13). Relationships between velocity and acceleration.
Newton's First and Second Laws	Dynamics using a force probe and motion detector to measure forces applied to low and high friction carts, and the resulting velocity and acceleration. Relationships among velocity, acceleration and force.
Newton's Third Law	Using two force probes to allow students to examine the interaction forces between two objects during fast collisions and when one object is pushing or pulling another in constant contact.

Figure 1. Kinematics 2 sequence “Motion with Carts” of ILDs. The short descriptions of demonstrations are taken from ILD teacher materials.

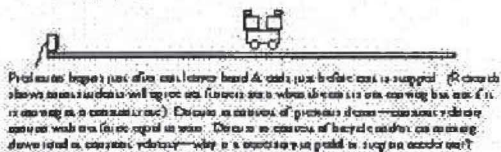
Demonstration #1: Cart (with very little friction) is pulled so that it moves away from motion detector, speeding up at a steady rate.



Demonstration #2: Cart with large friction (friction pad in contact with ramp) is pulled away from motion detector, speeding up at a steady rate.



Demonstration #3: Show that cart accelerates in either direction when only one fan unit is on (as seen in previous demos). With both fans on the cart does not move. Now push & release and observe the velocity and acceleration.



Demonstration #4: Cart with very small friction force is given a pull away from the motion detector and released.

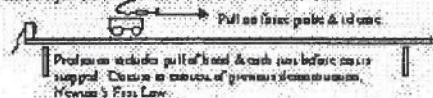


Figure 2. Newton’s 1st and 2nd Law ILD sequence. The short descriptions of demonstrations are taken from ILD teacher materials.

Figure 3. First part of student prediction sheet for ILD sequence on Newton’s 1st and 2nd Laws. This sheet is collected and students get credit if it is filled out. The predictions are not graded.

**Figure 3.** First part of student prediction sheet for *ILD* sequence on Newton's 1st and 2nd Laws. This sheet is collected and students get credit if it is filled out. The predictions are not graded.

INTERACTIVE LECTURE DEMONSTRATION		
PREDICTION SHEET — NEWTON'S 1ST & 2ND LAWS		
<p><b>Directions:</b> This sheet will be collected. Write your name at the top to record your presence in this class. Follow your instructor's directions. You may write whatever you wish on the other sheet, which is the Results Sheet, and take it with you.</p>		
<p><b>Demonstration 1:</b> The frictional force acting on the cart is very small (almost no friction). The cart is pulled so that it moves away from the motion detector speeding up at a steady rate (constant acceleration). Sketch on the axes below your predictions of the velocity-time, acceleration-time and force-time graphs for this motion.</p>		
<p><b>Demonstration 2:</b> The frictional force acting on the cart is now increased. The cart is pulled so that it moves away from the motion detector speeding up at a steady rate (constant acceleration). Sketch on the same axes above your predictions of the velocity-time, acceleration-time and force-time graphs for this motion.</p>		
<p><b>Demonstration 3:</b> The cart has equal and opposite forces acting on it. The frictional force is very small (almost no friction). The cart is given a push away from the motion detector and released. Sketch below your predictions of the velocity-time and acceleration-time graphs for the motion after it is released.</p>		

## INTERACTIVE LECTURE DEMONSTRATION SEQUENCES TO ENHANCE LEARNING OF NEWTON'S LAWS

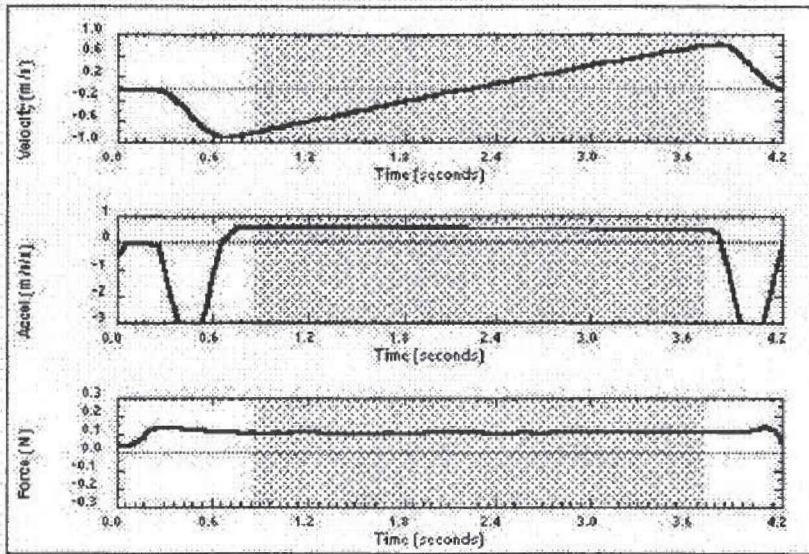
As an example of the effective use of ILDs, we will discuss the sequences that lead to an understanding of Newton's Laws. These sequences and others are available from the Center for Science and Mathematics Teaching. The motion detector, force probe and Tools for Scientific Thinking MacMotion software are discussed in the companion paper (1). We have developed four sequences of ILDs in mechanics to enhance the learning of kinematics and dynamics including Newton's Laws. Table 1 describes these sequences. Each sequence was designed to be done in approximately 40 minutes, although more time can be profitably spent (if available) discussing results with students.

The Kinematics 2 sequence of ILDs, Motion with Carts, is shown in Figure 1. The short descriptions are taken from the ILD teacher materials. The Newton's First and Second Law ILD sequence is shown in Figure 2. An excerpt from the student prediction sheet showing the first few predictions for this sequence is shown in Figure 3. (The students are given an essentially identical Results Sheet to fill out and take with them.) Figure 4 shows the graphs of a typical set of data for Demonstration 6 of this sequence as displayed in MacMotion using a force probe and motion detector. A force probe mounted on the low-friction cart measured the force applied to the cart by a weight attached to a string hung over a pulley (a modified Atwood's machine). (See Figure 2.) The cart was given a quick push opposite to the force exerted by the hanging weight, and it moved toward the motion detector, slowed down and returned. The shaded portions of the graphs show the time interval when the cart was moving under the influence of a

constant force.

Figure 4. Typical results from Demonstration 6 of the Newton's 1st and 2nd Law Sequence (Figure 2). These are actual data from an ILD given at Tufts. Display is from MacMotion. Motion of the low friction cart is described in the text.

**Figure 4.** Typical results from Demonstration 6 of the Newton's 1st and 2nd Law Sequence (Figure 2). These are actual data from an ILD given at Tufts. Display is from MacMotion. Motion of the low friction cart is described in the text.



## ASSESSING LEARNING GAINS FROM INTERACTIVE LECTURE DEMONSTRATIONS

Although the Tools for Scientific Thinking ILDs have been used successfully in many settings, we have been able to gather the most complete data on student learning at our own institutions. We have previously reported significant learning gains in kinematics and dynamics concepts for students who completed our active learning MBL laboratory curricula (1-5). Here we report on assessments of learning gains for introductory physics students at the University of Oregon during Fall, 1991, and at Tufts University during Fall, 1994, who experienced a series of kinematics and dynamics ILDs.

Figure 5. Cart on Ramp and Coin Toss questions from the Force and Motion Conceptual Evaluation. Student success at answering these questions can be found in Figures 6 and 7.

**Figure 5.** Cart on Ramp and Coin Toss questions from the *Force and Motion Conceptual Evaluation*. Student success at answering these questions can be found in Figures 6 and 7.

Questions 8-10 refer to a toy car which is given a quick push so that it rolls up an inclined ramp. After it is released, it rolls up, reaches its highest point and rolls back down. Friction is so small it can be ignored.



Use one of the following choices (A through G) to indicate the net force acting on the car for each of the cases described below. Answer 1 if you think none is correct.

- |                         |                              |                         |                            |                         |                              |
|-------------------------|------------------------------|-------------------------|----------------------------|-------------------------|------------------------------|
| <input type="radio"/> A | Net force acts up the ramp   | <input type="radio"/> D | Net force is zero          | <input type="radio"/> E | Net force acts down the ramp |
| <input type="radio"/> B | Net force acts down the ramp | <input type="radio"/> F | Net force acts up the ramp | <input type="radio"/> G | Net force acts down the ramp |
| <input type="radio"/> C | Net force acts up the ramp   |                         |                            |                         |                              |

\_\_\_ 8. The car is moving up the ramp after it is released.

\_\_\_ 9. The car is at its highest point.

\_\_\_ 10. The car is moving down the ramp.

Questions 11-13 refer to a coin tossed straight up into the air. After it is released it moves upward, reaches its highest point and falls back down. Use one of the following choices (A through G) to indicate the force acting on the coin for each of the cases described below. Answer 1 if you think none is correct. Ignore any effects of air resistance.

Questions 11-13 refer to a coin tossed straight up into the air. After it is released it moves upward, reaches its highest point and falls back down. Use one of the following choices (A through G) to indicate the force acting on the coin for each of the cases described below. Answer 1 if you think none is correct. Ignore any effects of air resistance.

- A. The force is down and constant.
- B. The force is down and increasing.
- C. The force is down and decreasing.
- D. The force is zero.
- E. The force is up and constant.
- F. The force is up and increasing.
- G. The force is up and decreasing.

\_\_\_ 11. The coin is moving upward after it is released.

\_\_\_ 12. The coin is at its highest point.

\_\_\_ 13. The coin is on its downward.

## Questions Used for Conceptual Evaluation

To evaluate student learning we present the results from a subset of the Force and Motion Conceptual Evaluation developed by the authors. This test has been described elsewhere (3, 5) and questions on Newton's 1st and 2nd Laws are shown and discussed in the companion paper in this publication (1). It has been developed to probe student understandings of dynamics. The choices on these carefully constructed multiple choice questions were derived from student answers on open-ended questions and from student responses in interviews.

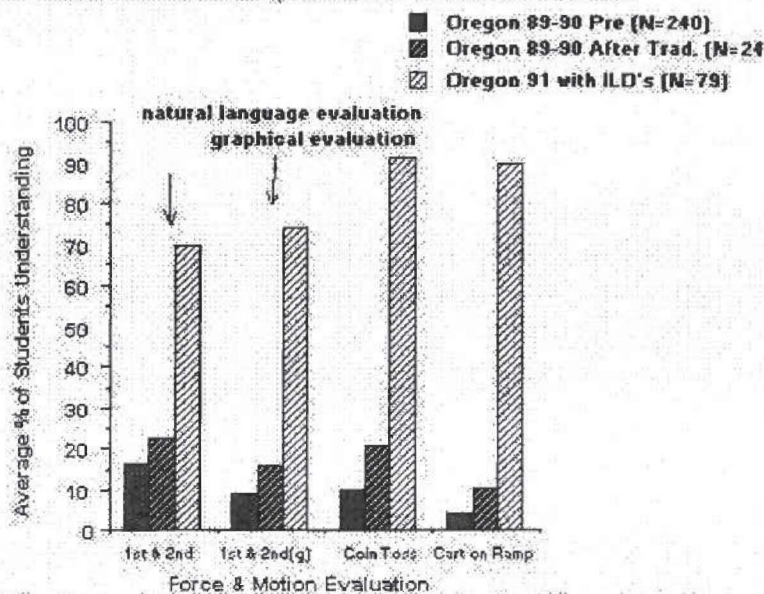
In this paper, we will focus on two sets of questions which investigate student views of force and motion (dynamics) concepts described by Newton's 1st and 2nd Laws, the "Force Sled" questions and the "Force Graph" questions (shown in Figure 6 and 7 of the companion paper (1)). In another paper, we discuss more completely evidence for the validity of the test, and also discuss the concern which some teachers have about multiple-choice testing (5). Here we will present summary pre and post-instruction results to examine how exposure to ILDs affects students' understanding of dynamics. References (1) and (5) discuss the substantial differences between the Force Sled (Natural Language) and the Force Graph (Graphical) questions and discuss the choice of an appropriate subset of these questions to indicate student understanding. In spite of



substantial differences in the form of the two types of questions, student responses are very similar where there is an exact analog between the Force Sled and Force Graph question.

Figure 6. Traditional instruction compared to ILD-enhanced instruction.

Figure 6. Traditional instruction compared to ILD-enhanced instruction.



The first two bars show student conceptual understanding of dynamics before and after traditional instruction in the Oregon non-calculus general physics course. The last bar shows the result of enhancing the introductory course with kinematics and dynamics ILDs. Only NOLAB students are included here. (Evaluation questions are discussed in the text.)

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In addition to these questions we will look at the results of the Coin Toss and Cart on Ramp questions (a coin toss analog) as shown in Figure 5. Such questions are in general even more difficult for students to answer correctly. (These questions are from a recent version of the test. Slight variations have been asked earlier (5).)

### Evaluation of ILDs at the University of Oregon

In the Fall of 1991, a series of kinematics and dynamics ILDs were used to enhance learning of Newton's First and Second Laws in the non-calculus (algebra-trigonometry based) general physics lecture class (PHYS 201) at the University of Oregon. This is a fairly standard introductory physics class except (1) there is no recitation, i.e., the class meets for four lectures with 200 or more students each week, and (2) the introductory physics laboratory is a separate course (PHYS 204), in which as few as half of the lecture students are simultaneously enrolled. Thus, the students in the lecture class may be divided into two groups, a NOLAB group which is enrolled only in the lecture course and

a LAB group which is enrolled in both the lecture and laboratory courses.

Students at Oregon were first introduced to kinematics with the Human Motion sequence of ILDs, looking at body motions just as in our laboratory curricula (2). Next, after all traditional kinematics instruction, the Kinematics 2: Motion with Carts ILD sequence was completed in 40 minutes of one 50-minute lecture. After all traditional lecture instruction on dynamics, the students experienced the Newton's First and Second Laws ILD sequence in 40 minutes of a 50-minute lecture period. Students were awarded a small number of points towards their final grades for attending and handing in their Prediction Sheets on the days when these demonstrations were carried out, but their predictions were not graded.

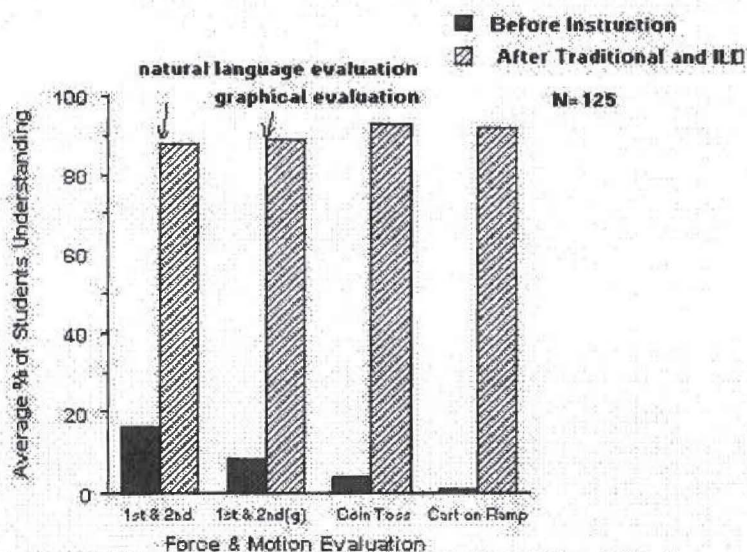
Figure 6 compares student learning of dynamics concepts in traditional instruction (where students listen to lectures, do homework problems, and take quizzes and exams) to learning in the identical course where just eighty minutes of lectures were replaced with ILDs. The pre-test results for Oregon students in 1991 (and for Tufts students in 1994 as shown in Figure 7 below) were very similar to those of the combined 1989-90 group of Oregon students which we show in Figure 6. Figure 6 also shows the 1989-90 Oregon student understanding after traditional instruction. As can be seen by a comparison of the first two bars in Figure 6, all traditional instruction results in only a 7-10% overall improvement on these dynamics questions. In comparison, the last bar shows that the effect of experiencing less than two full lectures of ILDs is very substantial for the 1991 Oregon NOLAB students who did not participate in the conceptual laboratories. (The addition of ILDs also improved the scores of the LAB students, but note that most of these students are able to answer the questions correctly after completing just the laboratories. See reference (1).)

### Evaluation of ILDs at Tufts University

A similar set of ILDs was carried out during Fall, 1994 in the non-calculus introductory physics class (Physics 1) at Tufts University, also with an enrollment of over 200. One difference from Oregon was that at Tufts' all traditional instruction in kinematics and dynamics was completed before any ILDs were presented. (The timelines at both Oregon and Tufts were necessitated by our desire to assess the effectiveness of the ILDs independently from traditional instruction. In 1995, in the same class at Tufts, results were equally good when the ILDs were more integrated into the lectures.) At Tufts, essentially all students were also enrolled in the laboratory, and had one traditional recitation session each week. They also completed two of our active learning (Tools for Scientific Thinking) kinematics laboratories but did not do any dynamics laboratories (2). (In the Oregon class, the NOLAB students who were not enrolled in the laboratory did not experience any hands-on laboratory work.)

Figure 7. ILD-enhanced instruction at Tufts University.

Figure 7. ILD-enhanced instruction at Tufts University.



The black bars show student conceptual understanding of dynamics before instruction at Tufts University in the Fall 1994 non-calculus general physics course. The striped bars show the result of enhancing the traditional introductory course with a kinematics and a dynamics ILDs. The Tufts 94 students also experienced two *Tools for Scientific Thinking* kinematics labs. (Evaluation questions are discussed in the text.)

The black bars show student conceptual understanding of dynamics before instruction at Tufts University in the Fall 1994 non-calculus general physics course. The striped bars show the result of enhancing the traditional introductory course with a kinematics and a dynamics ILDs. The Tufts 94 students also experienced two *Tools for Scientific Thinking* kinematics labs. (Evaluation questions are discussed in the text.)

Because of the kinematics laboratories, Tufts students began with the Kinematics 2: Motion with Carts ILD sequence (Figure 1) followed by the Newton's First and Second Laws ILD sequence (Figure 2). Both were done in 40 minutes of 50-minute lecture periods. As at Oregon, students were awarded a small number of points towards their final grades for attending and handing in their Prediction Sheets. (At Tufts, an additional forty-minute series on Newton's Third law was carried out after all traditional mechanics instruction. A preliminary report on the Third Law instruction can be found in reference (3). A more complete analysis will appear in a separate paper.)

The results of 80 minutes of kinematics and dynamics ILDs on student understanding of Newton's 1st and 2nd Laws are gratifying as shown in Figure 7. Remember that our results show less than a 10% gain for questions like these when students experience good traditional instruction.

### Persistence of Learning

The research data also show that the ILD-enhanced learning is persistent both at Oregon and at Tufts. As a test of retention, the Force Graph questions were included on the Oregon final examination. The final was given about six weeks after the dynamics ILDs, during which time no additional dynamics instruction took place. There was no decrease in understanding. In fact, there was a 6% improvement and little room for

further gain; i.e., the ceiling effect may be becoming important. At Tufts a final exam was given seven weeks after dynamics instruction (including ILDs) had ended. There was a 7% improvement. We have seen student understanding of concepts increase after instruction has ended in many contexts where there has been conceptual learning. We ascribe the increase to assimilation of the concepts by the students. Additional different questions about dynamics were also asked students at Tufts and more than 90% of students were able to answer them correctly.

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## CONCLUSIONS

Our studies of student understanding using the research-based Force and Motion Conceptual Evaluation with large numbers of students show that introductory physics students do not commonly understand kinematics and dynamics concepts as a result of thorough traditional instruction. This research and that of others, along with the development of user friendly microcomputer-based laboratory tools and our experience with computer-supported active laboratory curricula have allowed us to develop a strategy for more active learning of these concepts in lectures using Microcomputer-based Interactive Lecture Demonstrations. Assessments using the Force and Motion Conceptual Evaluation indicate that student understanding of dynamics concepts is significantly improved when these ILDs are substituted for traditional lectures.

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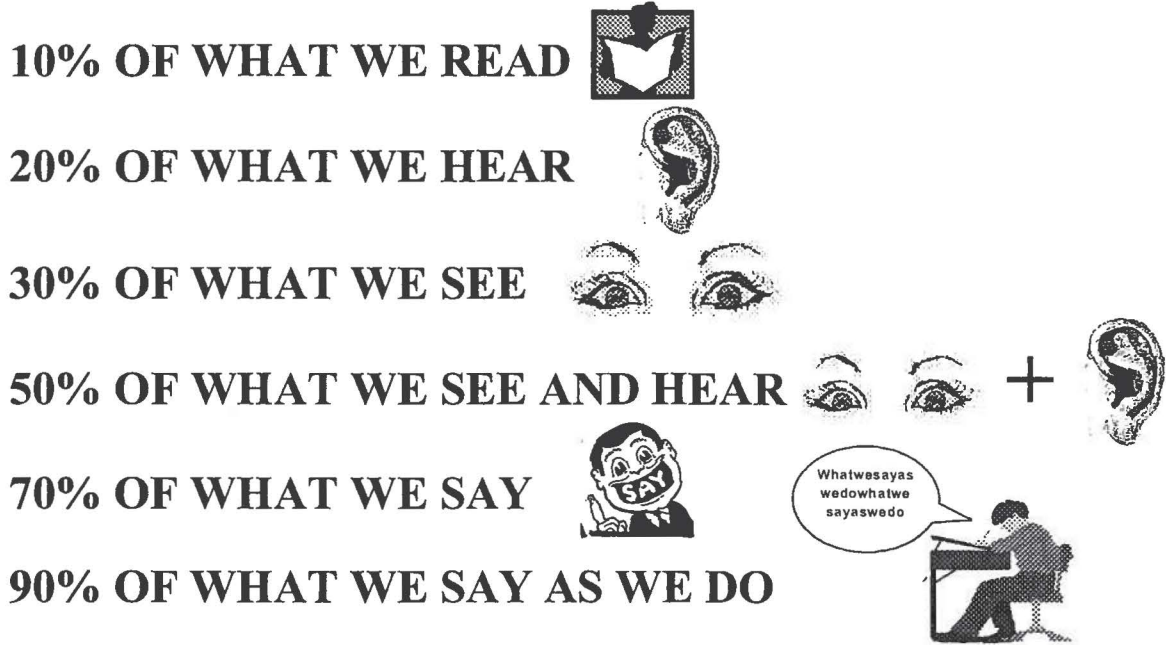
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# Passive vs Active Learning

STUDIES SHOW THAT OVER A PERIOD OF 3 DAYS, THE RETENTION OF LEARNING IS AS FOLLOWS:



ADULTS CAN LEARN BY READING, LISTENING, AND WATCHING, BUT THEY WILL LEARN BETTER IF THEY ARE ACTIVELY INVOLVED IN THE LEARNING PROCESS.