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## **AC 2011-2858: VIDEO LECTURE CAPTURE IN ENGINEERING CLASS-ROOMS WITH FREE**

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# Video Lecture Capture in Engineering Classrooms with Free Open-Source Software Tools

## Abstract

Teaching and creating education content through the use of tablet-PCs have gained popularity among the engineering faculty. The tablet-PC features, combined with screen capturing video tools, have the potential to be a promising technology to increase teaching and learning performance in both traditional and online courses. Advantages of using tablet-PCs, running Windows operating system and commercial screen capturing software, have been reported by many educators in the last few years. However, the availability and use of free open-source screen capturing video tools have not received much attention. Recent developments in user friendly open-source applications offer excellent alternatives to tablet-PC users in recording lectures and making the video files available for students' use. This article presents a review of free open-source software tools available for tablet-PCs running Linux operating system, and a summary of lessons learned from the teaching experience of three civil engineering technology courses taught in a traditional classroom setting with tablet-PC and free screen capturing video tools.

## 1. Introduction

Tablet-PCs make it possible to write on pdf or word files during the lecture and save them in desired file formats. The file that has instructor's inscriptions can be made available to students after the lecture. Recent advances in software and computer technology also let instructors to record both the screen and sound in a video file. The most important aspect of teaching the course with the tablet-PC was that students have the option to replay the movie as many times as they need to clarify concepts they missed in the classroom. It is this feature that was used and appreciated by the students most often, and has made the most positive impact in students' mind about the use of tablet-PC in the classroom<sup>1</sup>.

There are commercial software available to the tablet-PC users for screen recording, such as Camtasia<sup>3</sup> and Echo360<sup>6</sup>. Camtasia is a computer screen recording program. In addition to screen recording, it can simultaneously capture the video through a webcam. The video file then converted to "Windows Media Format" and can be uploaded to any online learning system for students' review. Camtasia and Echo360 can let users do some editing on the recorded video files.

Open-source products receive fund from supporting their product instead selling the product. As a result, a number of open-source software have reached maturity and are highly competitive with commercial products. This is also true for screen capturing software. Some Linux based free open-source software, such as RecordMyDesktop<sup>8</sup>, Istanbul, and SrenKast, provide excellent alternatives to instructors who may want to avoid slow performance of tablet-PCs loaded with Windows operating system and expensive recording software. Open-source operating systems and applications can run much faster on older tablet-PCs even with low memory and cpu speed. Installing a small solid state hard drive (SSD) may even boost the performance. A Linux

operating system with all screen recording applications takes less than 5 GB of disk space. Therefore, a small solid state hard drive, such as 32 GB, would be sufficient.

## 2. Linux Operating System

Linux is an open-source operating system. It is open because users and developers can use the source code any way they want. Linux is free. This allows companies to use it without adding cost to products. It also allows people to trade it freely. And, with the profit motive gone, developers have a heightened sense of community interest. The Linux community has developed a tremendous spirit because of these core development concepts<sup>2</sup>.

While Linux-based operating systems have grown much more approachable and predictable during the past several years, getting acquainted with Linux can still be little frustrating. Fortunately, there are lots of helpful people on the Internet who can answer your questions. Even better, there's a pretty complete log of the past questions and issues that others have already faced and solved waiting for you at your search engine of choice<sup>2</sup>. Brooks (2007) provides a good comparison of several different Linux distributions such as Fedora, Opensuse, Ubuntu, and Foresight for beginners. The author of this paper finds Ubuntu as the most user friendly Linux distribution.

## 3. Linux Tools For Screen Capturing

After the installation of a Linux distribution, the following software need to be installed to able to write on the screen and do screen capturing; Xournal<sup>11</sup>, RecordMyDesktop, DeVede<sup>5</sup>, and Cellwriter<sup>4</sup>.

Xournal is an application for note taking, sketching, keeping a journal using a stylus. It is a free software and runs on Linux. It is a Linux replacement for Microsoft Windows Journal. Xournal lets users annotate pdf files. The author prefers to prepare and distribute incomplete class notes before the lecture and annotate the pdf file containing the lecture notes. Figure 1 and Figure 2 show the screenshots of lecture notes taken with Xournal.

RecordMyDesktop is an easy to use desktop session recorder for Linux. It saves the movie files in OGG format. OGG is a completely open, patent-free, professional audio encoding and streaming technology with all the benefits of open-source<sup>7</sup>. OGG files can be played with VLC Media Player<sup>9</sup>; it is free and available for Windows platforms. Students can use VLC Media Player to play OGG video files posted by the instructor.

Figure 4 show a RecordMyDesktop window, initiated by pressing the button shown in Figure 7. Although it says advanced, a simple setup process must be completed by pressing the "Advanced" button as shown in Figure 4. The setup includes working directory, frames per second, sound device, and other settings as shown in Figure 5 and Figure 6. The numbers and selected options work best for the author's tablet-PC, and will probably work for most tablet-PCs. However, frames per second must be trialed to obtain the best sound-picture synchronization. There is no magic number, but it should be less than 25. In "performance" settings "Encode On The Fly" is selected, and it forces the computer to record and write at the

same time. Depending on the tablet-PC's capacity, this may cause a slowdown in the overall performance when inscribing on the screen. In order to avoid such an annoyance, the "Encode On The Fly" option must be deselected. After completing the setup process one needs to press the "Record" button on the "RecordMyDesktop" window to start the screen capturing session. The window will disappear and a square "stop" button will appear in the top bar as shown in Figure 7. By pressing the "stop" button, screen capturing session can be terminated. Once the session is terminated RecordMyDesktop creates the OGG movie file in the working directory with a name that looks like "out-1.ogv". This movie file can either be uploaded to a website for students' use or converted to an AVI (or any other format recognized by YouTube or podcasting channels) format by using a converter such as DeVeDe which is explained below. If the instructor wants to do some editing on the movie file, there are available open-source free movie editors for Linux and need to be installed separately. Since the author of this paper did not need any editing work, video editing part is not discussed.

DeVeDe is a program to create video DVDs and CDs, suitable for home players, from any number of video files. DeVeDe can be used to convert OGG video files to AVI video files which can be played by Windows Media Player. Conversion to AVI takes some effort to optimize and synchronize both sound and picture. Therefore, the author prefers to post OGG files and encourage students to use VLC Media Player to play the recorded lectures.

CellWriter is a grid-entry natural handwriting input panel. As you write characters into the cells, your writing is instantly recognized at the character level. CellWriter is not required to do screen capturing, but makes it easier to enter numbers and characters without using the keyboard when needed.

Journal - water\_in\_soil\_v1.pdf.xoj

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Example: An unlined irrigation canal runs parallel to a river and the cross section is shown in the figure. The soils in the region are generally stiff clays that are assumed to be impervious. There is a 200 mm-thick sand seam connecting the canal and river as shown, which continues to a length of 3.0 km along the river. Assuming that the permeability of the sand is  $2.3 \times 10^{-2} \text{ cm/s}$ , compute the quantity of water lost from the irrigation canal per day. (Take the water level in the river as the datum.)

Handwritten notes and calculations:

- $Q = kiA$  (Darcy's Flow Equation)
- $Q = k \frac{\Delta h_T}{L} A = 2.3 \times 10^{-2} \frac{\text{cm}}{\text{s}} \frac{(h_{TB} - h_{TA})}{250} \times 600 \text{ m}^2$
- $A = 3000 \text{ m} \times 0.2 \text{ m} = 600 \text{ m}^2$
- $Q = 954 \text{ m}^3/\text{day}$
- Additional notes: "I-D FLOW", "NO NEED FLOW NETS!", "hPB = |hTB|", "hTB = 0", "cross-sectional area. Flow direction  $\perp$  Area."

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### 1.5 Stresses in Soil Due to Flow

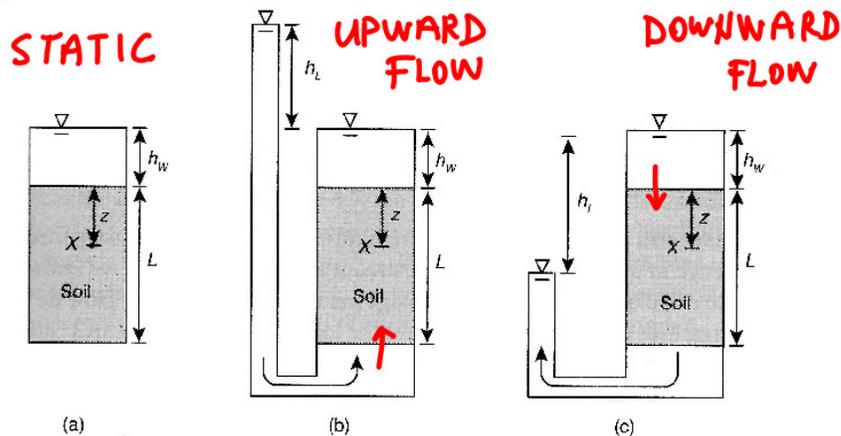


Figure 1: Screenshot views of an annotated pdf file used in a lecture.

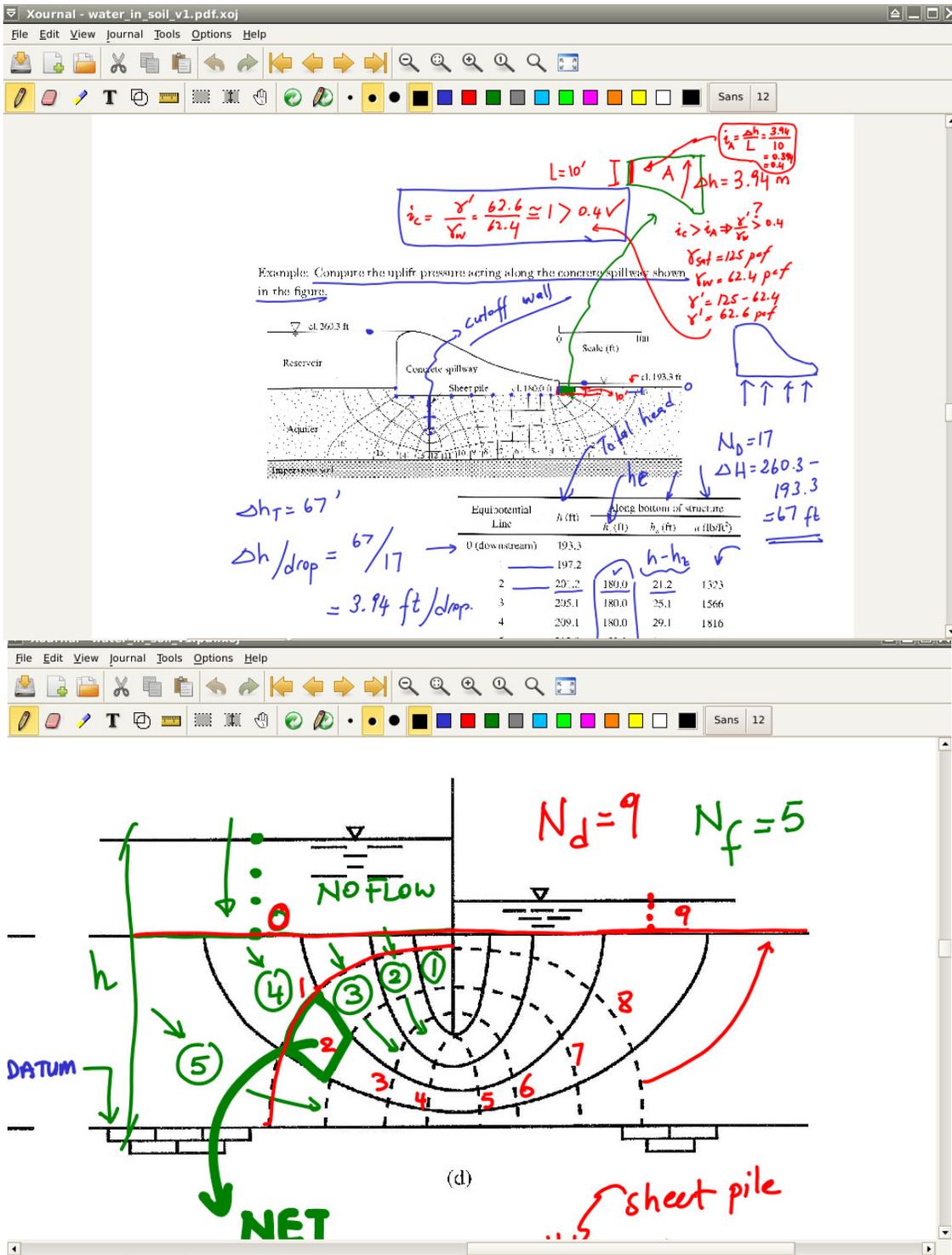
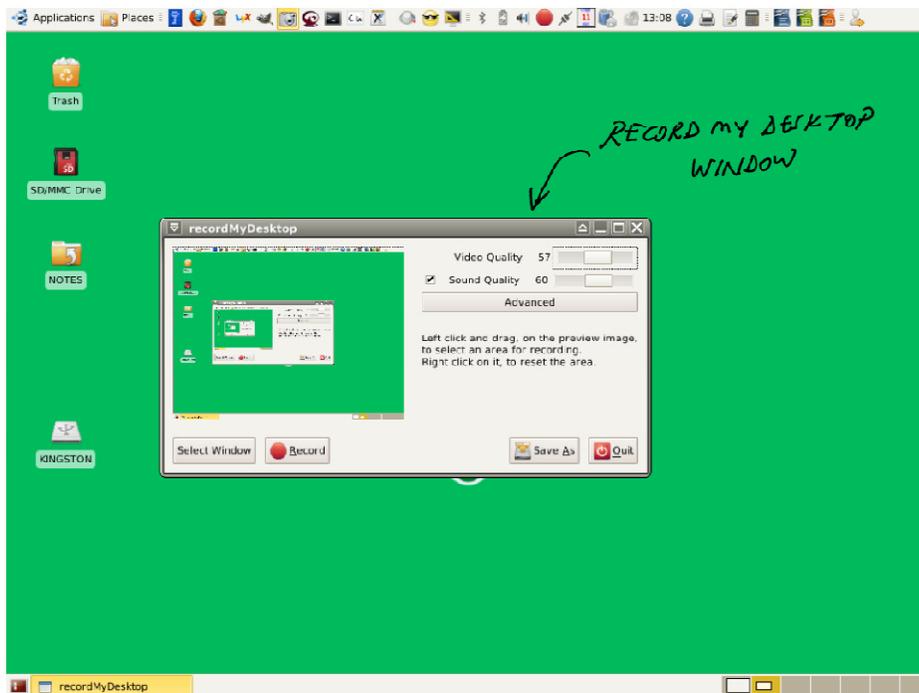


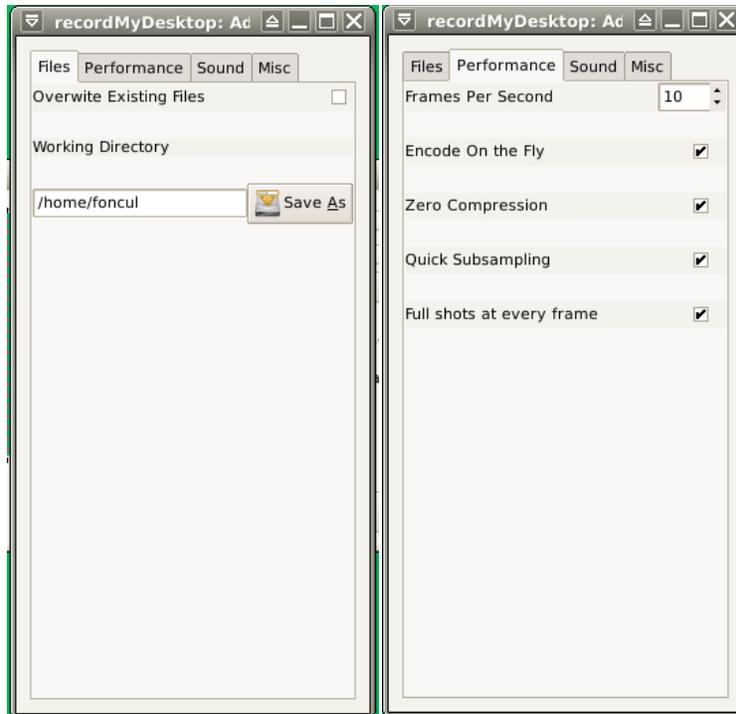
Figure 2 Screenshot views of an annotated pdf file used in a lecture.



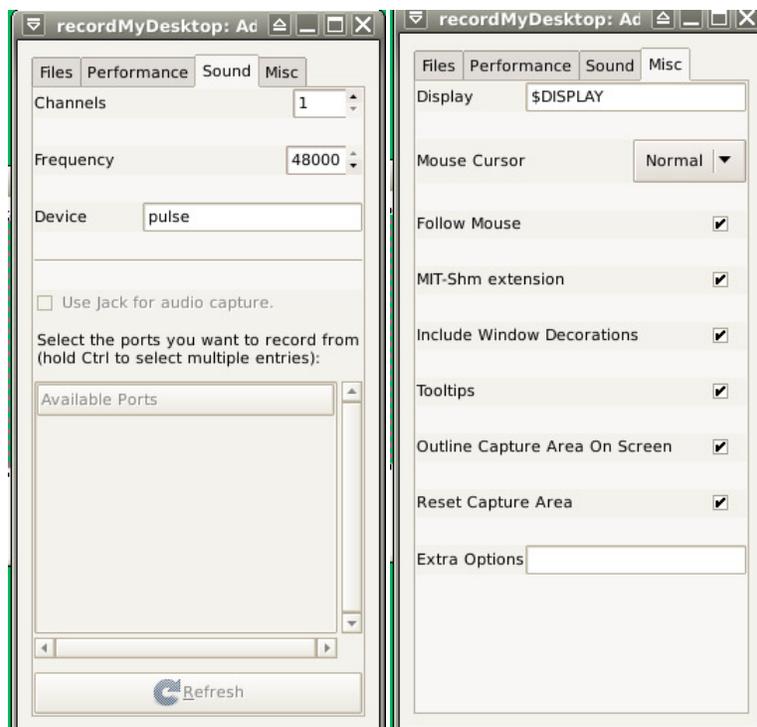
**Figure 3:** RecordMyDesktop window.



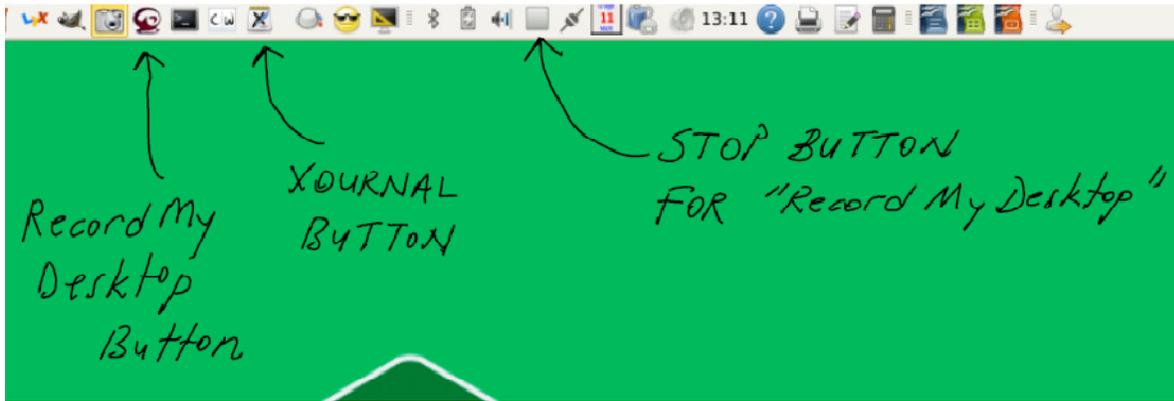
**Figure 4:** Closer view of RecordMyDesktop window.



**Figure 5:** “Files” and “Performance” tabs of “Advanced” settings in the RecordMyDesktop window.



**Figure 6** “Sound” and “Misc” tabs of “Advanced” settings in the RecordMyDesktop window.



**Figure 7:** Tablet-PC desktop during screen capturing session.

#### 4. Classroom Teaching Experience

The author used a tablet-PC (Lenovo X61, 3GB RAM, 64GB SSD), running Ubuntu Linux 9.04, in three civil engineering technology courses to deliver the lecture material. The courses are Soil Properties and Site Exploration, Foundations and Retaining Walls, and Dynamics.

At the end of the lecture two files were saved in the computer's hard disk: a) a movie file in OGG format, and b) Xournal file that contains everything that the author wrote on the computer screen. The Xournal file can be saved in pdf format without the need of using any pdf converter. Both files were uploaded to GeorgiaView/Vista learning system for students' review.

The courses were taught in a traditional classroom setting where the students are expected to attend the live lectures. The movie file of the recorded lecture and pdf files of the lecture notes served as the additional help material to support slow learners and those who missed the lecture for any reason. It should be noted that the author did not observe significant drop in class attendance due to the availability of recorded lectures.

A short survey was conducted to get students' feedback. Figure 8, Figure 9, and Figure 10 show the results of this survey for Soil Properties & Site Exploration, Foundations & Retaining Walls, and Dynamics courses, respectively. Majority of students indicated that they liked the tablet-PC style lecture delivery, and reviewed the recorded video files 5 times (on the average) or more during a semester. Some experienced technical difficulty in viewing files, but it has never been a major complaint. At the time when the survey was conducted, students used to view AVI files, converted from OGG files. Some unwanted noise could present in the AVI files due to the conversion process. The author stopped using the conversion process, and has provided the originally recorded OGG files to the students in the following semesters.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Rating Average	Response Count
I like Tablet-PC lecture delivery style.	0.0% (0)	0.0% (0)	8.3% (1)	41.7% (5)	<b>50.0% (6)</b>	4.42	12
Taking notes from the projector screen was convenient.	0.0% (0)	0.0% (0)	8.3% (1)	<b>50.0% (6)</b>	41.7% (5)	4.33	12
Screencast video recordings are useful for students' review.	0.0% (0)	0.0% (0)	8.3% (1)	41.7% (5)	<b>50.0% (6)</b>	4.42	12
I had no technical problems in downloading and viewing the video files.	0.0% (0)	8.3% (1)	<b>33.3% (4)</b>	25.0% (3)	<b>33.3% (4)</b>	3.83	12
How many times did you view the recorded video files? Strongly Agree: >10 -- Agree: 5-10 -- Neutral: ~ 5 -- Disagree: < 5 -- Strongly Disagree: 0	0.0% (0)	8.3% (1)	25.0% (3)	25.0% (3)	<b>41.7% (5)</b>	4.00	12
Professor should also post his lecture notes in addition to video files.	0.0% (0)	0.0% (0)	8.3% (1)	<b>50.0% (6)</b>	41.7% (5)	4.33	12
<b>answered question</b>							<b>12</b>
<b>skipped question</b>							<b>0</b>

**Figure 8:** Survey results for Soil Properties and Site Exploration

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Rating Average	Response Count
I like Tablet-PC lecture delivery style.	0.0% (0)	16.7% (3)	5.6% (1)	27.8% (5)	<b>50.0% (9)</b>	4.11	18
Taking notes from the projector screen was convenient.	0.0% (0)	11.1% (2)	16.7% (3)	22.2% (4)	<b>50.0% (9)</b>	4.11	18
Screencast video recordings are useful for students' review.	5.6% (1)	0.0% (0)	<b>33.3% (6)</b>	27.8% (5)	<b>33.3% (6)</b>	3.83	18
I had no technical problems in downloading and viewing the video files.	0.0% (0)	16.7% (3)	<b>27.8% (5)</b>	<b>27.8% (5)</b>	<b>27.8% (5)</b>	3.87	18
How many times did you view the recorded video files? Strongly Agree: >10 -- Agree: 5-10 -- Neutral: ~ 5 -- Disagree: < 5 -- Strongly Disagree: 0	11.1% (2)	<b>38.9% (7)</b>	11.1% (2)	22.2% (4)	16.7% (3)	2.94	18
Professor should also post his lecture notes in addition to video files.	0.0% (0)	11.1% (2)	22.2% (4)	27.8% (5)	<b>38.9% (7)</b>	3.94	18
<b>answered question</b>							<b>18</b>
<b>skipped question</b>							<b>0</b>

**Figure 9:** Survey results for Foundations and Retaining Walls.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Rating Average	Response Count
I like Tablet-PC lecture delivery style.	0.0% (0)	0.0% (0)	0.0% (0)	<b>66.7% (8)</b>	33.3% (4)	4.33	12
Taking notes from the projector screen was convenient.	0.0% (0)	0.0% (0)	0.0% (0)	<b>66.7% (8)</b>	33.3% (4)	4.33	12
Screencast video recordings are useful for students' review.	0.0% (0)	0.0% (0)	8.3% (1)	<b>66.7% (8)</b>	25.0% (3)	4.17	12
I had no technical problems in downloading and viewing the video files.	0.0% (0)	16.7% (2)	8.3% (1)	<b>58.3% (7)</b>	16.7% (2)	3.75	12
How many times did you view the recorded video files? Strongly Agree: > 10 -- Agree: 5-10 -- Neutral: ~ 5 -- Disagree: < 5 -- Strongly Disagree: 0	0.0% (0)	<b>36.4% (4)</b>	27.3% (3)	<b>36.4% (4)</b>	0.0% (0)	3.00	11
Professor should also post his lecture notes in addition to video files.	8.3% (1)	8.3% (1)	<b>33.3% (4)</b>	25.0% (3)	25.0% (3)	3.50	12
					<b>answered question</b>		<b>12</b>
					<b>skipped question</b>		<b>0</b>

**Figure 10:** Survey results for Dynamics.

## 5. Conclusions

This paper summarizes the author's experience in teaching three courses using a tablet-PC that runs Linux operating system and free screen capture software tools. The courses were taught in traditional classroom setting. Recorded video files were uploaded to the online learning system for students' review. Students indicated that they liked the tablet-PC style lecture delivery, and found the availability of video files very helpful. More importantly, the movie file of the recorded lecture and pdf files of the lecture notes served as the additional help material to support slow learners and those who missed the lecture for any reason. The tablet-PC features, combined with screen capturing video tools, have the potential to be a promising technology to increase teaching and learning performance in both traditional and online courses. As the open-source software tools are continuously improved and made more user-friendly, they will stay as an excellent alternative to Windows based commercial tools. Moreover, considering that even the older tablet-PCs, powered with open-source software tools, can perform the same recording job as the new Windows based tablet-PCs could do, this will continue to be more appealing to those who have already been frustrated with poor performance of Windows based software on tablet-PCs.

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