

# Enhancing Courses with Video Lessons

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**Abstract** Video lessons have been created to enhance teaching and learning of fundamental and advanced topics in surveying and geomatics. The videos were initially developed as teaching materials for a Pearson Education textbook in surveying. As experience was obtained through the use of the videos, other surveying topics related to several other courses were created to support traditional instruction efforts. This paper discusses the development and advantages of incorporating video lessons into a traditional lecture-style course. It presents the development of lessons, creation of support videos, and the students' reactions and uses. Improvements in student performance related to the use of these video lessons are investigated and show significant promise for this teaching and learning mechanism.

## Introduction

In 2010, Pearson Education requested that the author of the textbook *Elementary Surveying*, 13<sup>th</sup> edition (Ghilani, 2012) create video lessons for some example problems provided in the book. The process involves creating animated presentation slides that deliver short lessons and worked example problems. Over a period of 12 months, 94 video lessons for over 25 hours of instruction were created by Ghilani, first for the textbook, then subsequently for other teaching venues. At first the development of these videos was time consuming, and, quite frankly, considered a waste of time. Ghilani also felt that these lessons could potentially infringe upon the personally developed lessons of other instructors. However when the fall semester started, he asked his colleague Seybert if he was interested in providing these lessons to his students in his *Plane Surveying* class. Seybert agreed and used the video lessons as study review material prior to examinations. At the same time, Ghilani recognized that his distance students in his *Geodetic Models* class could benefit from instructional videos since their instructional support was strictly written material. Thus, Ghilani began to enhance his instructional lessons and develop video lessons to support this course.

The instructors had concerns about how resident students would use these lessons. Would they simply stop coming to lecture and limit their instruction simply to the video lessons? In doing so they would miss the interaction and discourse that always develops when presenting lessons. Or would they simply not view the video lessons since the lectures provided them with the material in an easier, structured format? Would they find conflict between the presentation styles of one instructor over another? And finally, and most importantly, would the video lessons enhance and improve the student's education?

There was another instructional concern. For example, when deriving an equation in a traditional class, it is possible for the instructor to go to a board and write the development steps with additional supporting background material during a lecture. While it is still possible to present the steps of deriving equations in a presentation package, often the viewer is left to their own abilities to determine how one equation suddenly becomes the next. Clearly, the class environment provides a stronger support structure for the student's learning but it also lacks one important element. Students cannot watch the lecture more than once. Thus, if they don't understand something at the time of the presentation, they have only their notes to guide them in their comprehension of the lecture material. As an example, while undergraduate students can watch an equation derivation, it is doubtful they can recreate the derivation at a later time. Thus some method of developing the equations in the presentation software was required to match the traditional lecture and to enhance it as well. Even with these concerns, it was recognized that the video lessons would enhance the educational experience of our distant students, so development of video lessons was continued and integrated into our coursework.

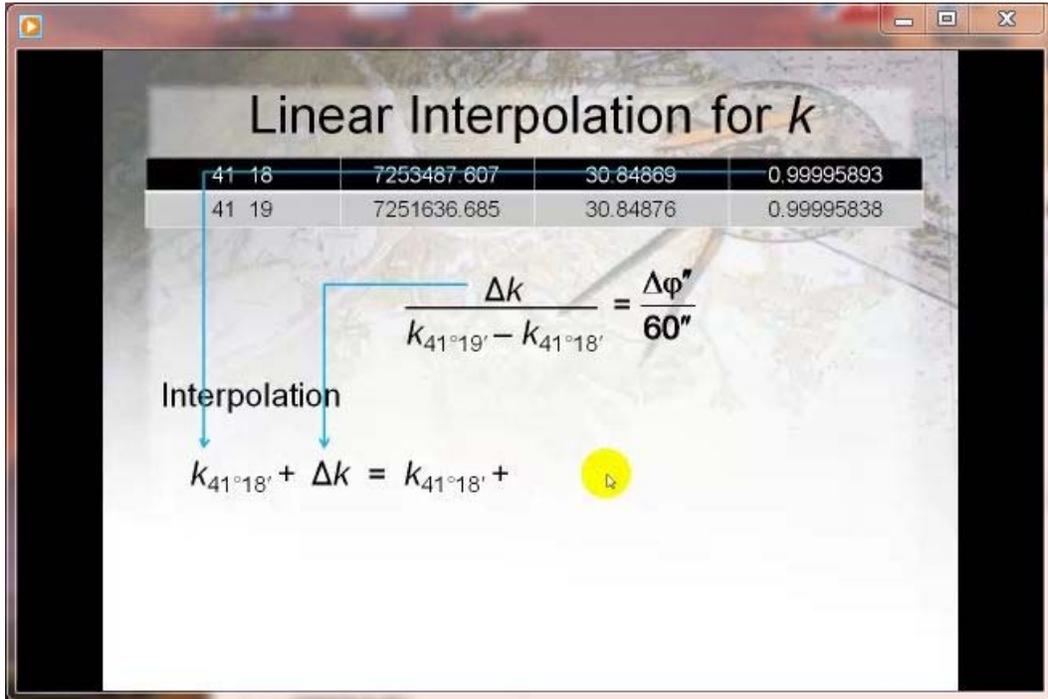


Figure 1 Use of lines and arrows to demonstrate linear interpolation.

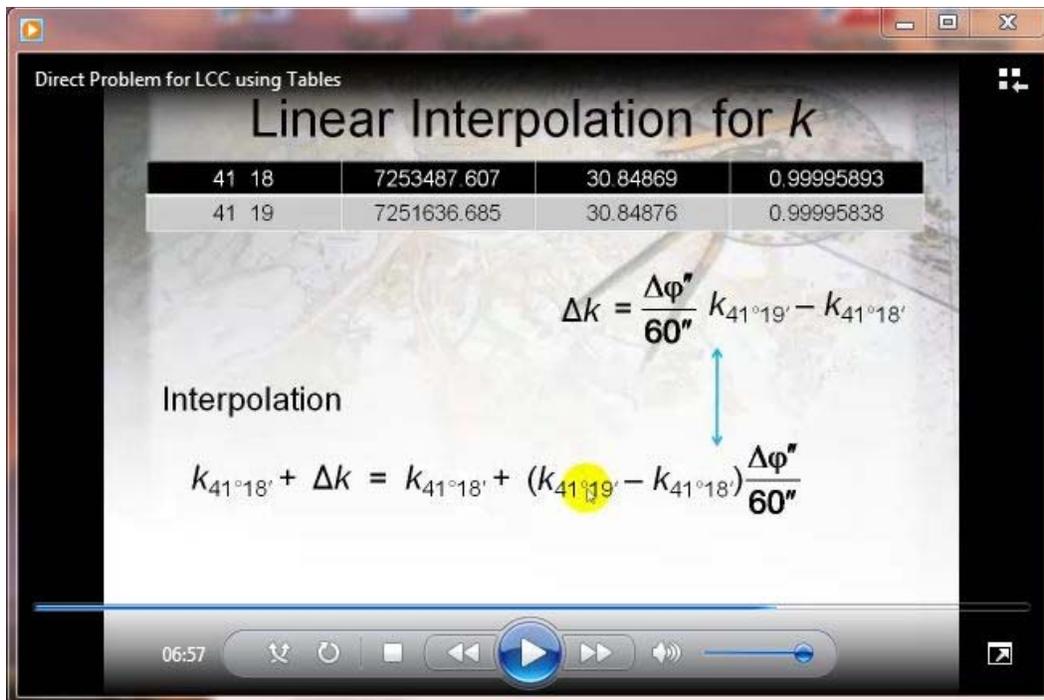


Figure 2 Animated graphic equation after animation of equation in Figure 1.

### Enhancement and Development of Videos

The production of the video lessons is a multi-step process beginning with the creation of a software presentation for each lesson. Since software presentations were already developed for the courses taught by Ghilani, the first step in the process was complete. However, effective delivery of these presentations relies on instructor interjection at any time during the lecture to further discuss or enhance a concept or derivation. Video lessons lack this capability. That is, once the video lesson is developed any missing material is left to the viewer to complete. Thus, thoughts regarding the improvement of the presentation to overcome this shortcoming are required. A solution to this problem was to provide animation graphics when developing an equation. This enhancement to the existing lessons could be nothing more than the addition of arrows and lines as shown in Figure 1, or it could involve an animated equation that rearranged itself upon queue by the presenter as shown in Figure 2. Quite honestly, this type of enhancement may only be necessary for lower-division students whose mathematical skills are still developing. However, this enhancement would not harm upper-division students and would provide a repeatable lesson once incorporated into a video.



Figure 3 Camtasia Studio video editing screen.

Once the presentations are developed, the production of the video can proceed. There are several e-learning packages that work with PowerPoint® including Camtasia Studio®, Articulate Presenter®, and Adobe Captivate®. This particular project was done with Camtasia Studio® based on the recommendations of the Penn State and Pearson Education instructional design staff. However all of these packages are capable of capturing screen actions, adding voice, providing editing capabilities, and producing a video in several file formats. Figure 3 shows a typical screen from Camtasia Studio®. Notice in the figure that there is a clip bin where video clips are stored. By default, the first video is added to the timeline at the bottom of the screen. The author found the clip bin useful when a particular slide in the presentation is deemed unusable after creation. When this happens, the offending slide is simply recorded again. Finally, the offending slide is deleted from the video and the new recording inserted into its location. Also shown in the timeline is an audio track. This track can be edited to eliminate stumbles by the presenter or audible pauses in the presentation. Another valuable feature in editing is the removal of noninformational delays. For example, the author may visit an Internet website or demonstrate a procedure or process in another software package. Inevitably when this is performed, time is lost due to loading of the other software package or website. This noninformational portion of the video can simply be deleted so that the viewer is spared this time delay. Additionally, there are times when a slide is found to contain errors or does not appear to present the topic in a clear fashion. When this happens, the author simply stops the presentation but allows the recording session to continue. The problem is then corrected and the presentation restarted. During the editing process, this segment of the video is deleted from the final video. The ability to delete any portion of the video is valuable when editing the work. Experience showed that it is faster to repeat a sentence or phrase rather than try to correct one misspoken word. Sometimes entire slides are repeated when the first attempt is deemed unsatisfactory.

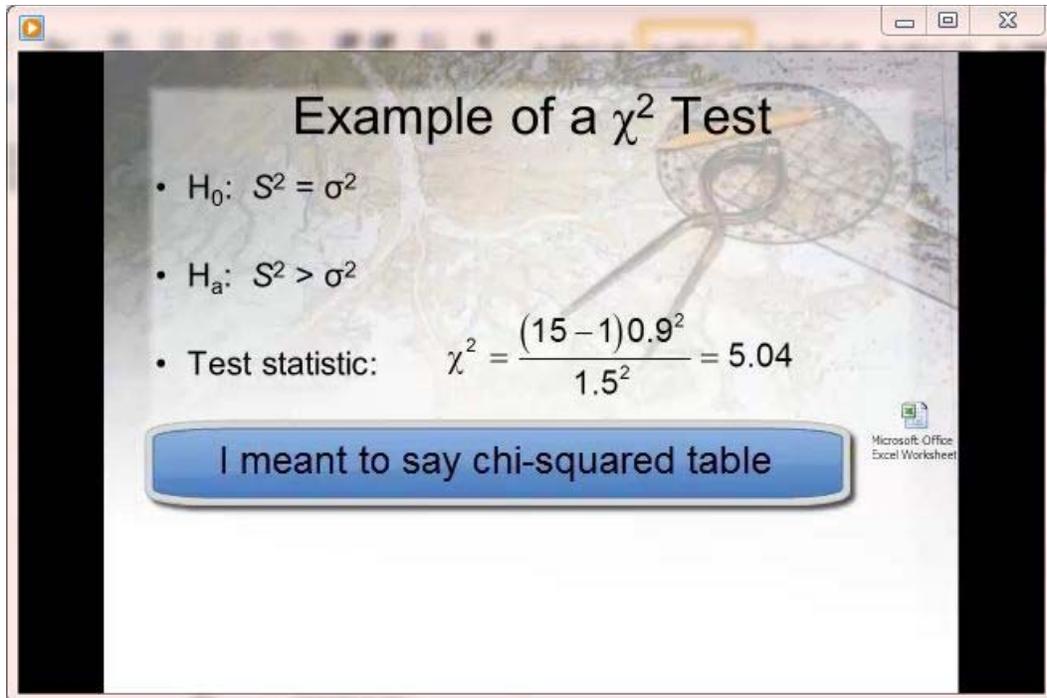


Figure 4 Demonstration of using a callout to correct an error in recording the video.

Other features that the author found useful are the *callouts* and *zoom-n-pan* features. Inevitably when recording a video a wrong term or word is used during the presentation. A *callout*, shown in Figure 4 informs the viewer of this mistake. The callout feature can also be used to emphasize a specific procedure. In Figure 5, the *zoom-n-pan* feature is used to zoom in on the relevant section of the table. It can also be used to zoom in on an important element on a slide. At the end of the editing, the author uses the *audio* feature in Camtasia Studio® to remove noise and increase or decrease the volume of the audio. Once satisfied with the final video, the *produce and share* menu is used to create a video of the presentation.

	A	B	C	D	E	F	G	H	I	J	K
1	0.999	0.995	0.990	0.975	0.950	0.900	0.500	0.100	0.050	0.050	0.050
2	1	0	0	0	0	0	0.016	0.455	2.705	3.841	5.000
3	2	0	0.01	0.02	0.05	0.10	0.21	1.39	4.61	5.99	7.30
4	3	0.02	0.07	0.12	0.22	0.35	0.58	2.37	6.25	7.82	9.30
5	4	0.09	0.21	0.30	0.48	0.71	1.06	3.36	7.78	9.49	11.10
6	5	0.21	0.41	0.55	0.83	1.15	1.61	4.35	9.24	11.07	12.80
7	6	0.38	0.68	0.87	1.24	1.64	2.20	5.35	10.64	12.59	14.40
8	7	0.60	0.99	1.24	1.69	2.17	2.83	6.35	12.02	14.07	16.00
9	8	0.86	1.34	1.65	2.18	2.73	3.49	7.34	13.36	15.51	17.40
10	9	1.15	1.74	2.09	2.70	3.33	4.17	8.34	14.68	16.92	19.00
11	10	1.48	2.16	2.56	3.25	3.94	4.87	9.34	15.99	18.31	20.40
12	11	1.83	2.60	3.05	3.82	4.58	5.58	10.34	17.28	19.68	21.90
13	12	2.21	3.07	3.57	4.40	5.23	6.30	11.34	18.55	21.03	23.30
14	13	2.62	3.57	4.11	5.01	5.89	7.04	12.34	19.81	22.36	24.70
15	14	3.04	4.08	4.66	5.63	6.57	7.79	13.34	21.06	23.68	26.10
16	15	3.48	4.60	5.23	6.26	7.26	8.55	14.34	22.31	25.00	27.40
17	16	3.94	5.14	5.81	6.91	7.96	9.31	15.34	23.54	26.30	28.80

Figure 5 Zoom feature used in video.

Other items that need to be considered are the format and length of the video and the final file format of the video. In order to ensure portability of the video across multiple platforms, the videos were produced in a 640 by 480 format. This format could be viewed on a iPad as well as on any computer. However, other options included the iPod and iPhone, which uses smaller formats, and HD, which uses a 1280 by 720 format.

Since the eventual destination of the videos is a server, download times must be kept to a minimum. If a video becomes too long, the download time becomes too long also. The author tried to keep the time of the videos below 20 min and preferably below 15 min. However, in some situations the videos involved the presentation of a single concept that took longer to present. This was especially true where several software packages were used. The longest video recorded was over 43 min long in its final form. This video was developed for the Elementary Surveying book and presented the cone as a developable surface, demonstrated the direct and inverse computations for the Lambert conformal conic map projection, and used additional software to perform these computations. In retrospect, the author could have developed this lesson in four parts. However, this lesson was for the Elementary Surveying book, and thus only one lesson was appropriate. In our map projection class, similar content is contained in five separate videos.

There are several choices for final video viewing formats. For example iPod, iPhone, and iTunes use M4V format. There are formats for specific players such as QuickTime or Flash. There are also formats for audio only. The authors chose the mp4 format since it could be viewed by several players including the media players that come with Windows-based and Apple machines.

## Metrics

Whenever software is presented in a computer lab, the students seldom stay on track, and the instructor often spends a considerable amount of time assisting those who become easily lost. Often the noise level increases as individuals seek assistance from both the instructor and their classmates. This scenario occurs each spring semester in the course *Coordinate Systems in Large-Scale Mapping*. In this fourth-semester course, the instructor demonstrates basic programming fundamentals using Mathcad®. Students then program coordinate conversions between the geodetic and several map projection systems. In the Spring of 2011, students were provided video lessons, which replaced the instructor's lessons. The immediate observation was that the room was quiet. Students on their own brought up the video lesson and started their programming project. It was, quite honestly, the most satisfying experience this author has had with this part of the course. Another observation was that the students progressed beyond their first programming experience and several worked ahead of the assigned projects on their own time. In fact, several of these students had completed their five programs, which included the direct and inverse computations for the Mercator, transverse Mercator, and Lambert Conformal Conic map projections before the material was ever covered in lecture.

**Table 1** Student responses to question, "What did you like most about the videos?"

No.	Response
1	They were easy to follow and i could look at the subject matter i needed when i needed it.
2	As a student here at Penn State I've always had difficulty comprehending text. Videos lessons were a great way for me to understand the material.
3	Could review each step again & again until the concept is understood.

Throughout the fall semester of 2010, only the distant students commented on the video lessons, stating that these lessons significantly helped them understand the concepts during the course. This led us to believe that the resident students were not using the video lessons, which was our fear from the start. However a survey at the end of the semester indicated that of the 21 students who completed the survey 3 had watched the videos several times, 5 had watched all of them at least once, 6 had watched most of them, 5 had only watched a few, and only 1 had not watched any videos. In the survey, the students were asked to comment on what they liked most about the videos. Table 1 shows the three responses that were provided for this question. Additionally they were asked to provide any additional comments at the end of the survey. Table 2 shows the 14 student comments for this question. Only one student commented negatively on the download time for the videos.

**Table 2** Student responses to the "Additional Comments" question

No.	Responses
1	Any additional instruction is always welcome. The availability at home is always convenient since I commute to campus and the visual along with the audio instruction help maintain learned knowledge.
2	The videos are great for me to review lecture notes. The professor's additional commentary about the lecture notes and PowerPoint slides really helped me get a better understanding of the material. They are very well done.
3	The videos allowed me to compare my notes taken in class to what was presented in the videos.

- They were very helpful.
- 4 For this class, my understanding of the material was strong, so viewing the videos was not really necessary for further understanding. However, the information in them is presented in such a way that if I were struggling to understand a concept, I believe they would be helpful.
  - 5 Helped me better understand certain areas I needed help with or was shaky on. Mostly used for exams.
  - 6 The videos were very helpful.
  - 7 I view the video lessons on occasion, and used them in combination with class notes to complete homework assignments and review topics.
  - 8 Extremely useful for re-evaluating class examples, which in turn helps on tests and/or homework.
  - 9 I viewed the video lessons on occasion and used them in combination with class notes to complete homework assignments and review topics.
  - 10 Extremely useful for re-evaluating class examples which in turn helps on test and/or homework.
  - 11 I wouldn't change one thing for the video lessons. They allowed me to better understand the material with the verbal explanation rather than just reading what was typed out. On at least 3 homework assignments the lessons explained things to the point where it cleared the confusion I had on a few problems.
  - 12 I did not watch many of them but i think it would be helpful to have practice problems separated from the lessons.
  - 13 Make sure the lesson encompasses the subjects of the homework questions.
  - 14 I didn't see all of your video lessons so you may already do this but Excel and MathCAD example problem videos would be very helpful. It's hard to take notes in class about how to use certain features in software as you are doing it in front of the class. If you could do the examples the same way you do in class in a video lesson I think it would make using the software (Excel/MathCAD adjust matrix) a lot easier.

The survey found that 65% of the students viewed the videos when studying for an exam. Eighty per cent viewed the videos when trying to do homework. Ninety per cent of the students stated that the videos allowed them to review the lecture at times when they needed. This is a strong indicator that students used these videos when the instructor was not present for assistance, which generally occurred after office hours. Only one student stated that the videos allowed them to view the lecture material when they weren't able to attend. To the question, "When I viewed a video lesson, it improved my understanding of the material," 100% of the students either agreed or strongly agreed with the statement. Only one student disliked the speed of the presentations. Finally when asked if they would view similar video lessons in future courses, 100%, including the one who had not watched any of the videos this time, either agreed or strongly agreed with the statement.

The final demonstration of the worth of the video lessons is in comparing student performance. While it is probably dangerous to compare the performance of students in different classes, this does provide a method of determining the value of the additional material. In Seybert's *Plane Surveying* course, the 2009 and 2010 classes were given the identical final exam. Final exams are not returned, so the issue of access to previous exams could not bias the data. The 2009 class did not have access to the video lessons for final exam review. The 2010 class did. However, the 2010 class was not provided with the video lessons

until two weeks before the final exam, and the video lessons provided were only those developed for Elementary Surveying, which did not cover all the material in the course. Statistics for the 2009 final exam scores were  $n_1 = 23$ ,  $\mu_1 = 79.0$  and  $\sigma_1 = 8.0$ . For the 2010 class scores the statistics were  $n_2 = 11$ ,  $\mu_2 = 84.1$  and  $\sigma_2 = 14.3$ . A statistical  $t$  test of two samples was performed on this data.

The null hypothesis was set to  $H_0: \mu_1 - \mu_2 = 0$  (the use of video lessons had no affect on final exam scores), and the alternative hypothesis to  $H_a: \mu_1 - \mu_2 < 0$  (the use of video lessons increases final exam scores). This creates a single-tail, lower-region test. For these data sets there is a significant effect of the dual-criteria grading method on final exam scores  $\{t(34) = -1.330, v = 30, t_{critical} = 1.310, p = 0.0974\}$ . This suggests that the use of video lessons increases final exam scores (null hypothesis rejected) at the 90% level of confidence. The  $p$ -value significance sets the level of confidence at 90.3%.

In Ghilani's *Coordinate Systems in Large Scale Mapping*, the statistics for the first exam in the class immediately preceding the video lessons was  $n_1 = 19$ ,  $\bar{y}_1 = 76.6$  and  $S_1 = 12.4$ . . The class that had access to video lessons had exam statistics of  $n_2 = 23$ ,  $\bar{y}_2 = 86.8$  and  $S_2 = 8.6$ . For these data sets there is a significant effect of the video lessons on exam scores  $\{t(42) = -3.0332, v = 30, t_{critical} = 1.310, p = 0.00717\}$ . This suggests that the use of video lessons increases exam scores (null hypothesis rejected) at the 90% level of confidence. The  $p$ -value significance sets the level of confidence at 99.3%.

## Conclusions

Contrary to the instructors' original fears, the students who had access to video lessons covering the classroom presentations still relied on attending the traditional class sessions as their primary method of learning. Students primarily used the video lessons to enhance learning and reinforce concepts outside of class. This provided the students with two modes of learning. When observing students watching video lessons, it was not uncommon to see them view the lesson, stop it, and return to a previously viewed spot to watch the material again. Another effect of the video lessons was that some students began to work ahead of the lectures. These students, about 25%, came to class prepared for lecture and often asked more in-depth questions demonstrating their advance knowledge on the subject.

An additional benefit was that the instructor was forced to review the lecture notes for completeness and clarity. As stated earlier, in a live lecture the instructor can explain any missing information on the board. However in a video, the viewer does not have this additional support. Thus animations were added to the digital lecture notes. While the content of the lecture notes remained the same, the addition of animations in graphics and equations, which could be viewed in the video, enhanced the presentations.

It takes a significant amount of time to develop the videos. For example, a 20-min video from scratch requires approximately 8 hours developing the presentation and another 4 hours creating the video. In classes where the lecture is already in a software presentation package, it took approximately 4 hours to enhance the presentation and another four hours to create the video. However, the payback has been worthwhile since students have improved their

comprehension of the subject material through a self-learning mode, without interaction with the instructor.

Finally the strongest indicator of the success or failure of the video lessons is the comments of the students that are shown in Tables 1 and 2, and the improvements in their comprehension of the material. What started as an unwelcome request by a publisher has become an on-going exercise to provide more courses with video lessons. If the professor's goal is education, then video lessons provide a statistically significant improvement over traditional lectures.

## References

Ghilani, Charles D. and Paul R. Wolf. 2012. **Elementary Surveying: An Introduction to Geomatics, 13th Edition**. Pearson Education, Upper Saddle River, NJ.

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