
High Production Quality on a Low Budget: Videos for Online Courses

Carmine T. Guida

Georgia Institute of Technology
New York, NY 10016
carmine@carmine.com

Abstract

As a graduate student, for my final project in an educational technology course, I opted to create an online course with video as the primary form of content delivery. I was inspired by videos in various Udacity.com and EdX.org courses. Typically, these videos are produced by a team of people with experience in video recording/editing, audio recording, lighting, photography and online course production. Additionally, the producers of these video courses often already have purchased and are proficient in the equipment and technology required to create these videos. During the development of my own course, I learned about the hardware and software needed to develop high production quality videos with a team of just myself on a student's budget. This paper details my reasons for creating the course and all of the equipment used in its development.

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for components of this work owned by others than ACM must be honored. Abstracting with credit is permitted. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee.

Request permissions from: carmine@carmine.com

Author Keywords

Online Course; MOOC; learning; e-learning; video production; lighting; audio; budget; games; open edx;

ACM Classification Keywords

K.3.2 Computer and Information Science Education.

Introduction

During the Fall 2017, I was a graduate student in the OMSCS (Online Master of Science Computer Science) program through Georgia Institute of Technology. I was enrolled in a course titled "Educational Technology" which involved various domains such as Learning Management Systems, MOOCs, Game-Based Learning and Online Learning. The course required exploring and researching an area of educational technology and then creating a project over an 8-week period. I opted to pursue the "content" track and create an online video course in 3D Game Development.

Why I Developed an Online Video Course

While developing an online course for an online course gave me a chuckle, my reasons for creating the course were more altruistic in nature with the hopes of providing a quality free educational resource. In the open access case, there is the opportunity to share the instructional courseware widely with many audiences for feedback and trials and to serve a broad community including those who may need additional learning experiences but are not interested in degree granting or credit bearing undertakings [1].

Why I Chose 3D Game Development

I wanted to answer the age-old question we asked in Math class, "when will I ever use this?" My goal is to make math engaging. Students in many cases found math, for the first time, to be useful because math became a tool that allowed them to build their video game [2]. Research has shown that students are highly motivated in Game Development courses:

"The instructor's experiences show that the motivation of students in this computer game-development course was very high. Students spent several hours applying new ideas to game designs and discovering the techniques that would make the realization of the designs possible." [3]

Game development also requires using many aspects of Computer Science besides graphics such as algorithms, networking and artificial intelligence. A course in computer game design and implementation provides a wonderful integration of many concepts in computer science for a heavily project-oriented course [4].

Course Learning Goals and Outcomes

The learning goal of the course is for students to have an understanding of 3D math as well as a basic understanding of how to use a game engine. The learning outcome is that the student can apply 3D math concepts and make a basic game. The course begins with an overview of 2D/3D math, then moves on to 3D models, followed by an introduction to the Unity game engine. The final unit includes making two simple games.

I arrived at this progression of the course from research into other Game Development programs for CS students. For instance [5] first semester 3D Game Development course featured "3D concepts, mathematics, hardware and software, APIs, object representation, file formats, camera control."

Production Quality and Style Matter

Online videos often contain mixed formats of presenting information such as filmed classroom lectures, “talking-head” of an instructor in a studio, power-point slides and drawing on tablets. Empirical study of student engagement with videos in MOOCs revealed the following which I integrated into the production of my course [6]:

- Shorter videos are much more engaging.
- Videos that intersperse an instructor’s talking head with slides are more engaging than slides alone.
- Khan-style tablet drawing tutorials are more engaging than PowerPoint slides or code screencasts.
- Videos where instructors speak fairly fast with high enthusiasm are more engaging.



Figure 1: My home studio setup.

A Video Studio is Born

Through trial and error (mostly error), I settled on a final setup. Figure 1 is a photo of my apartment in New York City which includes the following equipment used for filming:

- Green screen
- Video Camera and Tripod
- Teleprompter hardware (and iPad to scroll text)
- Foot pedal to scroll/reset Teleprompter
- Laptop (for recording video) and stand (tall for standing)
- iPad Mini (for drawing/sketching)
- HDMI Capture Adapters
- HDMI Cables
- Lavalier Microphone (audio)
- Large and Small LED Lights and stand

Some of this equipment I already had on hand from previous projects. I have dabbled in online classes before and was a full-time musician for a few years. Some of the equipment I purchased as I realized I needed it for this project. Neither of the two classes I was enrolled in during the semester required purchasing books and as a result I used those budgeted funds towards purchasing equipment.

You can skip purchasing some of this equipment. For instance, if you are on a tight budget, and you have someone else to help, they can be a “human teleprompter” and show you text/cards and change them as you speak.

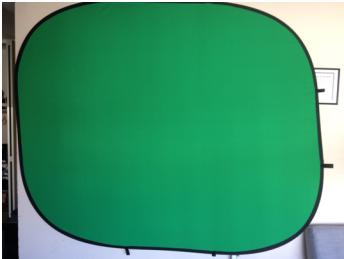


Figure 3: Green Screen
PhotoSEL 6.6' x7.9' collapsible
green screen: \$89

Throughout the rest of this paper, I will step through each piece of equipment and explain why I made the choice to use it and provide some explanation on how to use it when possible.

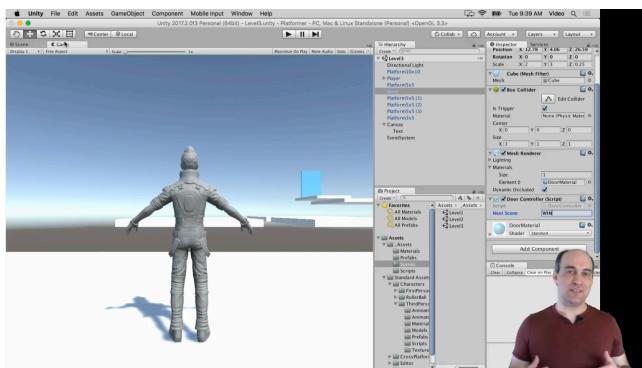


Figure 2: Live composite of Unity3D Game Engine with overlay video of myself (green screen removed via chroma key filter).

We're Live!

From prior experience, I learned that I did not want to "in post" attempt to align the video footage, audio recording and capture of my computer desktop (or iPad). As a result, I decided to composite everything on-the-fly so virtually no editing and post production would be required. This method also allows using free video editing software such as iMovie as no advanced editing features are required.

Figure 2 is a frame from one of my videos. The main part of the image is captured from my desktop computer while the lower right is a feed from my video camera. What you will not see in this image is the green screen. This has been removed using a "chroma

key" filter. The end result is a composite where only my body is covering the screen instead of a large block around me covering up too much of the display. This allows showing as much of the screen as possible while maintaining a human connection to my students instead of a disembodied voice.

Audio is recorded using a lavalier microphone which is plugged directly into the camera. This method also allows for minimal post production as the audio and video will be in sync by default.

OBS: Open Broadcaster Software

I used a free, open source and multi-platform program known as Open Broadcaster Software to composite the video sources and handle the green screen removal on-the-fly. The software allows setting up different "scenes" which can contain one or more video sources, audio sources and backgrounds. I had a scene setup with just the video camera source (full screen) and a black background for my "talking head" videos. I additionally setup a scene for capturing my iPad and another scene when capturing my desktop.

Green Screen

The real star of the show is the green screen. Utilizing the green screen, I can have various software, drawing apps, solid colors and more as backdrops. Originally, I used a simple cloth green screen sheet. However, it was subject to wrinkles which made removing it via chroma-keying very difficult. After my first couple of videos (and lots of frustration) I picked up the wire frame collapsible green screen pictured in Figure 3 in the sidebar. The wire frame keeps the fabric taut and uniform. This made for much easier chroma-keying. If you have the budget, I cannot recommend this enough.



Figure 5: Canon Vixia HF R700 Camcorder: \$199

Microphone input highlighted with blue. Live HDMI output highlighted in green.



Figure 6: Capture devices (from left to right)

AVermedia BU110 HDMI to USB-C capture device: \$249

Elgato Cam Link HDMI to USB3.0 capture device: \$129

Apple Lighting Digital AV Adapter: \$49

When using a green screen, it is preferable to stand at least 18" or more in front of it. This will help to avoid you casting too much of a shadow on the green screen and additionally cut down on the "spill" (this is green being reflected off the backdrop and on to you).

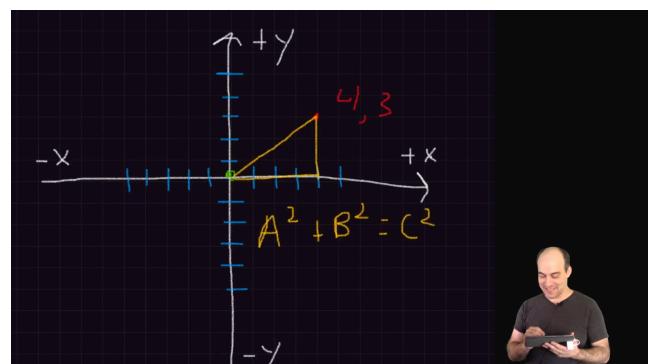


Figure 4: Live composite with iPad using a drawing app called Linea.

Drawing With an iPad

Khan-style tutorials "encourages professors to use the 'bar napkin' style of explanation rather than the less personal, more disjointed model that PowerPoint—if unintentionally—encourages." [6] Many of the decisions I made were based on being able to do this style of presentation. For my videos, I used an Apple iPad Mini and an app called Linea. This app featured a dark background and minimal UI which worked to create that Khan style look. You can see the final result in Figure 4.

Video Camera

You can potentially use a webcam, phone, tablet or any camera you have available to you. Be sure your device can record a resolution of 1920x1080 at 30 fps. I

already had a video camera from a previous project and when I originally purchased it, I had two requirements. The camera needed to have an HDMI output (live feed of what the camera was seeing) as well as a way to insert an external microphone. Figure 5 shows the ports available on the camera.

Capture Hardware

I needed to get the video camera feed into the computer (and OBS software) as well as the video from the iPad. This was accomplished using the capture devices and adapter pictured in Figure 6.

The Avermedia and Elgato adapters both have HDMI inputs and connect via USB-C and USB3.0 respectively. Both of these devices do not require any software to install. These devices essentially turn any HDMI input (camera, desktop computer, iPad, etc.) into a webcam. This provides compatibility with several pieces of software such as Skype and the OBS software I am using to perform the on-the-fly recording

The Apple Lighting Digital AV Adapter is connected to the iPad and provides an HDMI output which mirrors your iPad screen. This was then connected to the Cam Link adapter. I used the Avermedia device with my video camera's HDMI out.

Audio

If you only purchase one additional piece of equipment besides a camera it should be microphone. While cameras have built-in microphones, these typically can sound "roomy" or distant, especially when placed a few feet away from your subject. Fortunately, there are inexpensive lavalier (lapel) microphones available.

I have used the "BOYO BY-M1" as well as the "MOVO M1" lavalier microphones both around the \$20-\$30 range.

One of the benefits to using this type of clip-on microphone is that if you turn your body from side to side or look down at your keyboard, the lavalier microphone will still pick up your voice. Shotgun and other unidirectional microphones may lose volume if you are turned away from them.

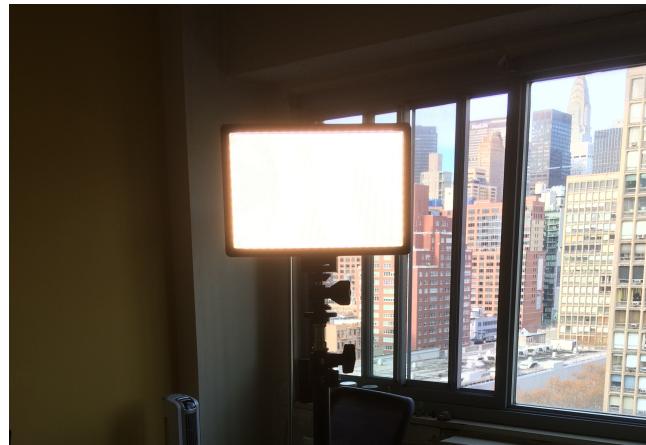


Figure 7: My LED "key" light.

Lighting

There are entire courses you can take on lighting. Typically, you would use a standard "3 Point" light setup. This would be a "key" light which is the main light on your subject. A "fill" light which fills shadows created by the key light and finally a "back" or "hair" light which points at the back of your subject's head to

help separate them from the background. You may additionally use a light to illuminate the background.

The most affordable light solution I found was to use the giant light up in the sky, the sun. This came with some caveats. The best time to film using sunlight is an hour after sunrise and an hour before sunset. I filmed my course during the winter which means I had even less sunlight than usual.

In addition to sunlight I used an LED light as my "key" light to help illuminate my face with a warm tone (Figure 7). LED Lights are inexpensive, lightweight and also do not generate heat. Due to the sun unevenly lighting my green screen, I used a second light to brighten up the other half of the background to make it more evenly lit which made the chroma-keying process much easier.

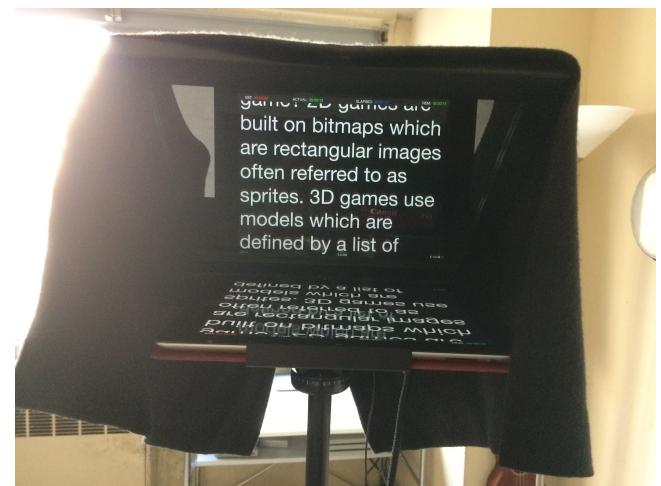


Figure 8: My view of the teleprompter.



Figure 9: Side view of camera inside teleprompter.

Teleprompter RS8-10: \$139



Figure 10: Musicians page-turning foot pedal.

PageFlip Butterfly: \$89

Teleprompter

I would categorize a Teleprompter as a “nice to have” addition to your setup. The earlier part of my course was based on reading scripts. I originally used a piece of paper next to the camera. However, when reviewing my own video, I could see my gaze was drifting from the camera to the paper. It was clear I was reading something off to the side.

Teleprompters are typically cost prohibitive. I was able to find an inexpensive solution that was a camera mount and plate of glass at an angle. This solution also uses an old tablet and I found an app called Teleprompt+ to be useful. You can see my view of the teleprompter in Figure 8 and a side view of the camera inside the teleprompter in Figure 9.

A rather fun addition to the teleprompter was a wireless foot controller meant for musicians to turn sheet music pages on tablets (Figure 10). I was able to use one I had to pause and scroll the teleprompter without having to move at all.

Problems/Issues Throughout Semester

In Figure 1 and Figure 7 you can see some of my apartment in New York City. I live near a hospital and there are frequent siren sounds as well as construction noise. This constant noise ruined perfectly good recordings. Additionally, this project was created during the winter which limited the amount of available daylight I could use (my primary and freely available light source).

What I would Do Differently

Each week I would have an issue and after becoming frustrated (not enough light, too hard to remember

lines, too much noise, etc.) I would acquire something to solve the problem. I learned that drawing on an iPad is surprisingly difficult. For my next video project, I would have everything I needed before starting. I would practice the iPad drawings I was going to use. Finally, I would find some inexpensive remote (or rentable) space to do all of the filming to avoid noise and distractions.

Final Thoughts

Looking directly into a camera and talking with no one else in the room can be awkward at first. I relaxed into it as time went on. They say the camera adds 10 pounds, but it also removes 20% of your energy. You need to be slightly over the top for it to translate well to the other side of the screen. I have a new respect for teachers who are putting themselves out there to be viewed and potentially criticized by tens of thousands of students.

Acknowledgements

I would like to thank my CS6460 mentor Brandon King for his guidance during my project as well as my instructor Dr. David Joyner for providing an opportunity to challenge myself. I would additionally like to thank Michael Dearborn (a friend and Assistant Director for Film/TV shows) for his advice on lighting and using the green screen more effectively.

References

1. Carr-Chellman, A., & Duchastel, P. (2000). The ideal online course. *British Journal of Educational Technology*, 31(3), 229-241.
2. Repenning, A., Webb, D., & Ioannidou, A. (2010). Scalable game design and the development of a checklist for getting computational thinking into public schools. Proceedings of the 41st ACM technical symposium on Computer science education - SIGCSE 10. doi:10.1145/1734263.1734357
3. Cagiltay, N. E. (2007). Teaching software engineering by means of computer-game development: Challenges and opportunities. *British Journal of Educational Technology*, 38(3), 405-415.
4. Jones, R. M. (2000, May). Design and implementation of computer games: a capstone course for undergraduate computer science education. In ACM SIGCSE Bulletin (Vol. 32, No. 1, pp. 260-264). ACM.
5. Roden, T. E., & Legrand, R. (2013). Growing a computer science program with a focus on game development. Proceeding of the 44th ACM technical symposium on Computer science education - SIGCSE 13. doi:10.1145/2445196.2445362
6. Guo, P. J., Kim, J., & Rubin, R. (2014, March). How video production affects student engagement: An empirical study of mooc videos. In Proceedings of the first ACM conference on Learning@ scale conference (pp. 41-50). ACM.