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Effects of YouTube Video as Pre-Lecture Preparation

Sang M. Yim
United States Military Academy, sang.yim@westpoint.edu

Eric Sturzinger
United States Military Academy, eric.sturzinger@westpoint.edu

Christopher J. Lowrance
United States Military Academy, christopher.lowrance@westpoint.edu

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Major Sang Myong Yim, United States Military Academy

MAJ Sang Yim received his commission from the Hawaii Pacific University ROTC in 2006 as a Signal Officer and was assigned to Camp Castle, South Korea. He served as the Division Automation Officer for 2nd Infantry Divison, Regiment Automation Officer for 160th Special Operations Aviation Regiment, Signal Detachment Commander for 1st Battalion 3rd Special Forces Group. MAJ Yim has deployed twice to Afghanistan in support of Operation Enduring Freedom. MAJ Yim's military education includes the Signal Officer Basic and Advanced Course, Information Systems Manager Course, Airborne, and Ranger schools.

Lt. Col. Christopher J. Lowrance, United States Military Academy

Lieutenant Colonel Christopher J. Lowrance is an Assistant Professor and the Deputy Director of the Electrical Engineering Program at the United States Military Academy at West Point. A native of southern Indiana near Louisville, Kentucky, LTC Lowrance received his commission as a Distinguished Military Graduate from the Virginia Military Institute in 2000. Since entering active duty, he has held multiple command and staff positions as a Signal and Functional Area 26A (Network Systems Engineer) officer over the last 18 years. His past military duty positions include: Signal Platoon Leader, 32nd Signal Battalion, Darmstadt, Germany; Assistant Brigade S-3 Operations for the 22nd Signal Brigade; G-6 Signal Officer for V Corps Artillery, Schwetzingen, Germany; Company Commander of Delta Company, 551st Signal Battalion and Delta Company, 369th Signal Battalion, 15th Signal Brigade, Fort Gordon, Georgia; Chief of Enterprise Operations, Southwest Asia Cyber Center, Camp Arifjan, Kuwait. He has deployed twice for year-long assignments to Baghdad, Iraq in support of Operation IRAQI FREEDOM I from 2003-2004 and to Camp Arifjan, Kuwait to support theater communications in Southwest Asia from 2012-2013. LTC Lowrance's education includes a Bachelor's Degree in Electrical Engineering (EE) from the Virginia Military Institute, Master's Degree in EE from the George Washington University, and Ph.D. from the University of Louisville in Computer Engineering. He is also a graduate of the Signal Officer Basic Course, Signal Captain's Career Course, and the Army Command and General Staff College. At West Point, LTC Lowrance also serves as a senior researcher in the Robotics Research Center. He has led multiple research projects related to robotics, artificial intelligence, and machine learning. His research has led to over 25 peer-reviewed journal and conference papers, several of which have won best paper awards.

Major Eric M. Sturzinger, United States Military Academy

MAJ Eric Sturzinger is a Network Systems Engineer (FA26A) who has served in various positions across multiple combatant commands. He initially served as a Platoon Leader in B Co., 52nd Infantry Regiment (Anti-Tank), 2nd Stryker Brigade Combat Team, 25th Infantry Division from 2009-2010 at Schofield Barracks, HI. MAJ Sturzinger then deployed to Iraq in support of Operation Iraqi Freedom and Operation New Dawn from 2010-2011, serving as Executive Officer of HHC, 2nd SBCT, 25th ID. Upon graduating the Telecommunication System Engineer Course in 2012, he served as Systems Engineer of 7th Theater Tactical Signal Brigade in Schweinfurt, Germany from 2012-2013 and later as Systems Engineer of 44th Expeditionary Signal Battalion from 2013-2015 in Grafenwoehr, Germany where he regularly supported EUCOM, CENTCOM, and NATO operations, exercises, and training. MAJ Sturzinger is currently serving as an Instructor in the Department of Electrical Engineering and Computer Science at the United States Military Academy. His academic interests include Future Internet Architectures, Network Science & Optimization, Machine Learning, and Artificial Intelligence. He is a graduate of the Infantry Officer Basic Course, US Army Airborne School, the Telecommunications System Engineer Course, and the Signal Captains Career Course.

Effects of YouTube Videos as Pre-Lecture Preparation

Abstract

Classroom lectures convey course concepts more effectively when students have prepared in advance. Traditionally, students prepare for lectures by reading the course textbook. Textbooks are the default study material for most educational courses; however, some technical subjects are better conveyed in video format. Therefore, in this study, we required students to supplement their learning resources with web-based video tutorials that provide detailed demonstrations with the respect to technical network configuration and management. Our course, Cyber 350 (CY350), Network Engineering and Management, introduces the entire spectrum of the student body to current practices in the design of network topologies and configuration, troubleshooting, and management of network devices such as routers and switches. YouTube is a video sharing website that can provide free educational tutorials and instructions on technical subject matter, where students can observe practical human-machine interaction to prepare for lectures and increase overall course performance on exams, assignments, and laboratory projects. Our goal was to compare the overall performance as well as the level of active class participation between two groups of the same computer networking course. We found that the group that used YouTube videos for pre-lecture preparation, consisting of 83 students, scored approximately 3% higher on exams but 5% lower on homework assignments than the control group (textbook only), consisting of 81 students. There was no statistical significance between the two groups with respect to overall course grades. Study habits and degree of class participation of each student correlated more strongly with overall course performance than whether the student viewed the videos.

Introduction

Web-based video streaming services have changed the way students can learn technical concepts previously accessible only by textbooks or physical lectures. With the advent of Massive Open Online Courses (MOOCs) and other online educational programs of varying formats, virtually every subject, especially those technical in nature, is available in video demonstration and tutorial formats.

Although textbooks for any undergraduate-level course elucidate concepts in rigorous detail and provide meaningful examples, they often lack visual and audio components, leaving some students unable to visualize how concepts are applied or implemented. In video tutorials, however, students benefit from "live" learning environments as they visually show procedural steps as would a real instructor in a physical classroom. In computer networking courses, students learn design, engineering, and configuration practices primarily by trial and error. Thus, video

tutorials provide a recorded version of common equipment behavior as well as realistic reactions to human actions, something a textbook is unable to do.

While the widely-held notion that students can be classified into visual, auditory, or experiential learners has been largely discredited by Pashler et al.[1], there is no doubt that students certainly have preferences for the way they learn material. Students generally consider video content to be more enjoyable and less time-consuming than written material; hence, video tutorials give them the flexibility to focus their time on learning difficult concepts that require extra practice.

Technical subject matter, such as the configuration and operation of sophisticated network equipment, is challenging to teach by textbook alone. Though books contain vast amounts of information, the effective operation of highly specialized equipment, (e.g., network routers and switches), requires hours of "hands on" practice. This practice, along with knowledge gleaned through textbooks, reinforce one another, and student outcomes should improve if neither resource is employed exclusively. For example, a student can better understand the effect of executing a command on a router (changing the configuration of the router) by viewing the router's output while an expert explains the process in real time. It is impossible to develop any IT-related skill by reading a textbook without any interaction with the studied system. With information and educational resources becoming increasingly ubiquitous, the traditional model of information conveyance within a live lecture may only survive in very specific disciplines that require instructor or student-to-student interaction.

This paper analyzes the effects on student performance in an undergraduate-level computer networking course by requiring 83 students to view existing YouTube videos as a pre-lecture preparation method and comparing their performance on graded events and comparing to a group of 81 students who used the course textbook as the primary learning resource. Our primary contribution in this study is the analysis of whether video tutorials had an impact on individual lecture preparation and overall course grades. In addition, we measured disparities in student feedback on the effectiveness of supplemental YouTube videos as compared to using textbooks as the sole resource. The remainder of this paper is organized as follows: Section II covers related work, Section III documents the analytical method, Section IV contains the quantitative results, Section V discusses implications of the results, and Section VI concludes the study.

Related Work

Much of the recent literature contains studies that experiment with additional multimedia, web-based resources as part of the overall learning experience. We have found that most have been a part of broader research on so-called "flipped" classrooms where students study material prior to class and use the dedicated time period for discussion, group work, and peer/instructor feedback. They mostly sought to not waste precious class time with simple information transfer; rather, a majority of the material itself can be learned prior to class, which is used to reinforce concepts and apply them in a semi-practical and realistic scenario.

Kerr conducted a survey of these experiments within specific disciplines of undergraduate engineering courses[2]. The survey details particular studies in which the flipped approach had a

significantly positive impact on student experience. In many cases, the preference depended on the type of course material itself. Courses such as "Network Engineering and Management" are task-oriented in nature and can be practiced without significant expert supervision. For practical technical courses, a demonstrator's or narrator's explanations from interactive videos can be just as effective as those from a live instructor.

Vial et al. studied the use of video tutorials for the operation of lab equipment and how to conduct the lab procedures themselves[3]. This allowed the instructor to help truly struggling students without having to show every student how to complete a simple task. Most students could follow the video tutorials without too much difficulty, thus they could advance at their own pace.

Jolley et al. found that prelab videos and e-quizzes better prepared students for laboratory exercises in an undergraduate chemistry course[4]. They concluded that prelab content reduced the cognitive overload of students having to manage the concept focus of the lab along with the procedural components of its execution. Surveys showed that student learning experience improved as lab prep and execution seemed less daunting due to visual aids and prelab web-based quizzing.

Hans and Jan van der Meij showed how integrating video-based supplemental previews and procedures increased the ability of elementrary school-aged students to complete Microsoft Word tasks successfully by 38% over exclusively paper-based tutorials[5]. However, integrating video content did not improve post-test performance, only the completion of tasks themselves. The previews were meant to strengthen the users' perception of task relevance while the procedures sought to link "users action to software reaction."

Ellington and Hardin described how student use of video tutorials for an undergraduate mathematical modeling course allowed the instructor to focus more time on primary course learning objectives while minimizing time spent on assisting students in troubleshooting code and model setup.[6] Although a thorough understanding of and competence in the use of modeling software is important for experimentation, the software-specific tasks required to build a model can be done on the students' own time at their own pace without instructor assistance.

Sharkey and Nurre demonstrated the benefits of integrating video tutorials in an undergraduate operations research (OR) course and found that approximately 72% of the students viewed most or all of the provided video tutorials[7]. As an introduction to an OR concept, students viewed videos prior to class and then again during lecture for formal methodology description. This allowed for a less-rushed class period and students prioritized office-hour questions to acquire a deeper understanding of the material as opposed to asking simple questions answered by the videos.

Martin and Ross surveyed several works related to using video tutorials for distance learners. Several suggestions for making effective videos are noted in their survey.[8] Overall, they found that there are a variety of tools and techniques available for creating videos and not every style is right for every lesson. Some interesting statistics based on the viewing of YouTube tutorials from their university's library include the following. On average, only 35% of viewers completed video tutorials regardless of duration and the average viewer only watched about 54% of a tutorial before quitting, suggesting that the most pertinent information should appear in the first half of the video.

Wu et al. investigated the key factors of student learning satisfaction in a blended e-learning environment, where instruction consisted of a mix of face-to-face and online education.[9] They argued that a blended learning environment has the potential to maximize the best advantages of both instructor-driven and online education. Using questionnaire data, they discovered that computer self-efficacy, system functionality, content feature, and interaction all impact a student's expectations, learning climate, and satisfaction of a course.

Lim et al. looked at the differences in learning outcomes and student perceptions between students enrolled in two variants of a course (i.e., online versus blended versions)[10]. From the 125 students in their study, they concluded that no significant differences existed in learning achievement; however, differences were found in learning satisfaction based on course survey data. More specifically, learners in the online format reported significantly higher workloads and less learning support than those in the blended environment.

Method

Network Engineering and Management, also known as Cyber 350 at the United States Military Academy (USMA), is an introductory undergraduate networking course which covers the design, implementation, and management of modern computer networks. It is a part of a three-course cyber engineering sequence, which gives students a broad introduction to the technical aspects of the cyber domain. Fundamental computer network standards and protocols are studied and applied using modern Cisco routers and switches as well as network simulation software. At the end of the course, students are expected to have mastered the material to the degree that they are able to pass the Cisco Certified Entry Networking Technician (CCENT) certification exam. CY350 is mandatory for information technology (IT) majors and satisfies a networking course requirement for computer science (CS) majors at the USMA.

Ten sections from the course were observed during fall semester of 2017 and spring semester of 2018. Five sections during the fall semester of 2017 followed the traditional lecture preparation approach of textbook readings while the other five sections during spring semester 2018 were provided with links to YouTube videos, hand-picked by the instructor before every lesson. For the purpose of this paper, the sections that followed the traditional textbook readings are referred to as "Reading Group", and the sections that was provided with YouTube video links are referenced as "Video Group".

The two observed groups were similar regarding class year breakdown and the ratio of STEM to Non-STEM majors while the reading group had a 3.1 incoming grade point average (GPA) compared to 2.9 for the video group, as shown in the Table 1 below.

Table 1: Academic Background for Students Enrolled in CY350

	Reading Group	**Video Group**
Class	52 Seniors; 29 Jrs	37 Seniors; 46 Jrs
Grade Point Average	3.1 out of 4.0	2.9 out of 4.0
STEM Major Ratio	25 out of 81	34 out of 83

The textbook used in CY350 is "CCNA Routing and Switching Study Guide" by Todd Lammle, Wiley Publishing, ISBN: 978-1-118-74961-6. The required lecture readings averaged 15 and were no more than 20 pages in length. The lecture topic and associated page numbers were displayed on the internal CY350 course website. This reading was mandatory for students in the reading group and optional for the video group before lectures. The video group was instructed to view specific YouTube videos that were selected by the instructor which closely mirrored respective textbook content as a mandatory pre-lecture requirement. While the reading group was not required to view the videos, we did not restrict access to applicable videos, which could have resulted in some students in the reading group using both resources. This method is different from other video related education research as the instructor did not personally create the video content for the students. It also is not ideal in that the selected videos did not always exactly match textbook content, however, it proved more efficient in saving lesson preparation time for the instructor. The instructor chose from videos that met the following requirements:

- The topics covered in the video closely match the subject matter in the textbook readings and all of the lesson objectives
- The video covers most or all of the material in the textbook readings
- Duration of the video must be no more than 20 minutes
- The main demonstrator or instructor speaks clear English with minimal accent

A total of 63 out of 83 students in the video group provided end-of-course feedback in spring 2018 regarding the effects of YouTube videos on lesson preparation and learning. Surveys were not completed for the reading group because 2017 fall semester precedes this study, but records of homework assignments, lab project grades, exam grades, and participation activities were compared and analyzed between the two observed groups.

Results

Performance

Table 2 depicts the statistical result of a unpaired t-test of the two groups in terms of combined lab, test, homework, and final grades. The table also shows overall grades had no statistical difference between the two observed groups. The video group performed slightly better than the

Table 2: Statistical Performance Comparison between Two Groups

	d.f.	**mean %**	**std. d. %**	**t-stat.**	**p-value**
Video Lab	82	84.9%	11.2%	0.52	0.602
Read Lab	80	83.9%	12.6%		
Video Test	82	83.1%	9.0%	2.10	0.037
Read Test	80	80.0%	9.6%		
Video HW	82	77.7%	16.2%	-2.11	0.037
Read HW	80	82.5%	12.4%		
Video **Final**	82	82.6%	9.3%	0.45	0.654
Read **Final**	80	81.9%	8.9%		

*t-statistic and p-values were calculated using the *scipy* library on Python 3.6.2. Positive t-statistic value indicates video group has a higher score, while negative indicates reading group has a higher score.

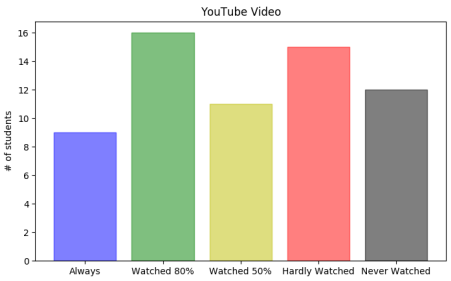
reading group, 82.6% vs. 81.9% in average overall grade but the p-value of the unpaired t-test was 0.654, thus we are unable to reject the null hypothesis that the two groups are similar. Also for the combined lab grades, the video group performed slightly better than the reading group, but the p-value was still high at 0.602, which again, prevents us from rejecting the null hypothesis.

The three exams in CY350 cover broad networking topics including routing, switching, and security. All three exams are similar in format: short answer, fill in the blank, and task-oriented problems which require technical configuration commands. The combined exams are worth 30% of the overall course grade. The two groups had a noticeable difference in combined exam grades: the video group outperformed the reading group by 3%, averaging 83.1% and 80.0% respectively. The p-value of the unpaired t-test was 0.037, which is statistically significant to reject the null hypothesis that the video and reading groups are similar.

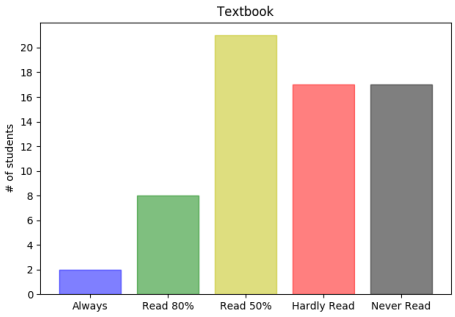
There are 15 homework assignments worth 15% of the total grade. The first four assignments are intended to be a tutorial in which students follow instructions to learn common procedures. The other 11 assignments are challenging as they build upon prior assignments and expect students to have mastered the materials from previous lectures. The reading group outperformed the video group by 5% in the average homework assignment grades. For the combined homework assignment grades, the p-value of the unpaired t-test was 0.037, which is statistically significant to reject the null hypothesis that the two groups are similar.

Pre-lecture Activities

From the survey given at the end of spring 2018 semester, students frequently watched the provided YouTube videos while textbooks were hardly read before lectures. As shown in Figure 1(a), out of 63 respondents: 25 stated they watched the videos at least 80% of the time, 11 stated they watched the video 50% of the time, and 27 stated they hardly or never watched videos before lectures. As shown in Figure 1(b), only 10 out of 63 respondents read at least 80% before lectures while 21 read 50% of the time and 34 students hardly read the textbook before lectures.



(a) Number of students who watched YouTube videos prior to class



(b) Number of students who read textbook prior to class

Figure 1: Statistical breakdown of pre-lecture activities

Lecture Participation

Lecture participation between the two groups is hard to compare due to its subjectivity, but they were rather similar. One group did not standout over the other, but certain type of students participated more in lectures regardless of the group. Class size of the observed groups were between 13 to 18 students but only 1 to 3 students were most active with class discussions and exercises. All noted students who were most active during lectures received at least a B+ for their final grade. Moreover, the active students who responded to the survey stated they watched the videos or read the textbook at least 80% of the time. There was a notable difference in participation statistics on the Piazza collaboration site between the two groups. The reading group had higher participation with 140 posts (questions) with 517 contributions (replies/comments) compared to 47 posts with 100 contributions by the video group. Most posts were questions regarding problems with homework and lab assignments.

Discussion

Preferences for YouTube videos Over Textbook Reading

In this study, students preferred watching YouTube videos over reading the textbook to prepare for lectures and exams. According to the survey of 63 respondents, students thought videos were easy to understand and not as time consuming as reading the textbook. 52 students stated the provided YouTube videos were above average, using words such as “excellent” and “awesome” to describe the educational quality of the videos. 48 students also stated the videos were very easy to follow and mentioned that videos were short and could be viewed anywhere at their convenience. Moreover, 54 students preferred videos over textbook readings stating that the latter were long and dry, complicated and hard, and the time invested was not worth the reward. Many of these responses led us to believe that much of the video content produced a lighter cognitive load required by students of translating examples into knowledge and skills to solve their specific

problem or task. On the contrary, textbooks seemed to require a greater mental effort to convert concepts and screenshots of command outputs along with text-based explanations into the requisite skills to correctly configure and troubleshoot network equipment.

This does not imply videos are always preferred by the students over textbook readings. The YouTube videos were chosen by the instructor to ensure they were relevant to the material and easy to follow. There were numerous videos on YouTube with the same or similar topics, but the best one was always chosen at the instructor's discretion. Further, the textbook used in the course was published in 2013 and consists of 1176 total pages. It has been updated to include more visual-based examples and its own virtual lab simulator. Also, the thickness and the small font size of the textbook could have had a negative psychological impact on the students. Therefore, if YouTube video quality had been poor and updated textbooks were used, student feedback on learning materials may have been much different.

Video Group Performed Better on Exams

As mentioned earlier, the video group scored 3% higher on the combined average exam grade than the reading group. This might be related to the video group frequently viewing the YouTube videos even after lectures, an example of refreshing content and procedures on a periodic basis. In the survey, most students stated they would review class notes and homework assignments, then review the videos to understand or relearn the concepts prior to taking exams. On the other hand, only two students mentioned they read the textbook to prepare for exams.

Students at USMA have a very busy schedule due to mandatory athletic activities and military drills on top of maintaining a minimum academic course load of 15 credit hours every semester. Many students at USMA try to find the optimum method to maximize their study time and, in many cases, feel watching a video is more rewarding than reading the textbook. YouTube videos used for this study were clear and topic-focused, largely step-by-step processes to provide the optimal learning experience to the student. Therefore, students would watch the videos to better understand the objective and purpose of the assignments due to visual demonstrations with explanations that are easy to understand and follow. On the other hand, students stated the textbook reading was too long and hard to understand. In the survey of 63 respondents, 12 stated they would only skim the textbook for a key configuration command or a protocol to find a command syntax or the definition. This method would be useful for completing homework assignments but not on the exams because students still needed to figure out the detailed meaning of the command with proper sequences of configurations and protocols to answer short questions on the exams.

Reading Group Outperformed on Homework Assignments

Surprisingly, the reading group scored 5% higher on the combined average homework grade than the video group. An explanation of this outcome could be that video group was more successful on the first exam, and therefore the students did not invest time on homework assignments because each assignment is only worth 1% of the final grade. On the first exam, the reading group

had an average grade of 83% while the video group averaged 91%. The latter group of students likely felt they could maintain their course grade by concentrating on major graded events while spending less time on homework assignments. This would also explain why there was less participation on the Piazza collaboration site from the video group. In this study, Piazza was used for students to post questions and replies for group collaboration. The instructors monitored the Piazza site so students did not share wrong information or actual answers for homework and lab assignments. Most of the posts on Piazza were problems encountered on homework and lab assignments. The video group only posted 47 questions compared to 140 by the reading group. Moreover, there was a notable difference on homework assignment quality where students from the reading group were more timely and complete on turning in assignments compared to the video group.

Habits of Top Performing Students

It is worth noting only a few top students referenced the textbook during the course. Out of 21 students who received 'A' for the course and responded to the survey, 19 students stated they hardly read before lectures and did not reference the textbook even before exams. The students stated the readings were not worth the time that needed to be spent in order to understand the material. To get ready for exams and lab project assignments, the students stated they would take good notes during lectures and concentrate on the concepts that are covered in homework and in-class exercises.

There were some differences in how top-performing students watched videos compared to the rest of the students. 17 out of 21 top performing students, in terms of overall grade, stated they watched the videos, taking notes while pausing and rewinding as necessary. Most students who watched the videos prior to lectures stated they viewed them immediately before lectures or before going to sleep the previous night without mentioning whether they took notes. This activity might explain why there was not much difference in class participation and overall grade between the two groups. Regardless of study material, top performing students adequately prepared for class and were most active during lectures. Most students, on the other hand, would only take studying seriously when preparing for a major graded event such as an exam or lab assignment.

Comparing the Overall Performance

Overall, most students stated YouTube videos were a good source to understand technical computer networking concepts in preparation for exams. Therefore, students in the video group frequently referenced the videos and scored higher on exam grades compared to the reading group: 83.1% vs. 80.0%. However, the video group scored significantly lower on homework assignments compared to the reading group: 77.7% vs. 82.5%. As mentioned earlier, this might be due to student complacency after the first exam and showing apathy to assignments that are worth less in terms of their contribution to the overall grade. The two groups had similar performance on lab assignments where the video group performed slightly better compared to the reading group: 84.9% to 83.9%, respectively. In terms of successfully completing lab

assignments, neither learning method was particularly useful as they required the students to effectively combine many concepts to solve a unique and complex problem. Therefore, as indicated in the survey, most students did not particularly reference the provided YouTube videos or the textbook, completing the lab assignments primarily by trial and error and seeking help when they encounter a problem.

As depicted in Figure 2, the two groups received similar final grades. This suggests that while YouTube videos were used by students to better prepare for exams, overall grades depended on internal student motivation and study habits.

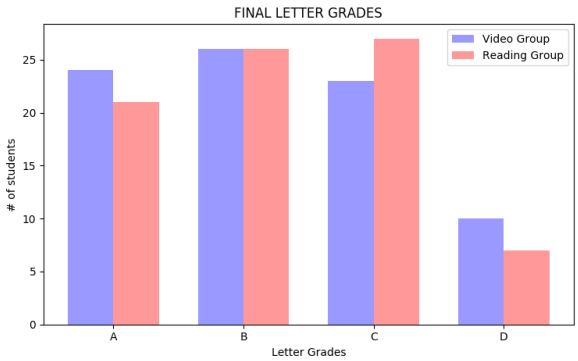


Figure 2: Final letter grade breakdown for CY350

Conclusion

This study shows that the video group did engage in pre-lecture preparation by watching YouTube videos, but they did not outperform the reading group with respect to the final course grade with any statistical significance. The video group did outperform the reading group in terms of combined exam grades by 3%, even with an inferior average GPA. Moreover, active lecture participation and good study habits correlated more to superior performance in the course than did whether students used videos or textbooks as their primary study resource. Therefore, students must adequately prepare for lectures (regardless of study material format) and actively participate during lectures to perform well in the course. There could be an argument that video content is easier to digest than textbook readings, contributing to a psychological benefit which could indirectly affect student performance, but further research is needed to corroborate this argument. For example, students learning from either the textbook or videos may receive the same academic benefit, however, those that viewed the videos may have had a more enjoyable, less cognitively demanding experience. This contributes to a false or misleading sense of understanding of the underlying core concepts as students were able to use the videos to simply repeat procedures shown in the videos, demonstrating knowledge of only superficial characteristics of the material.

Although the notion of “learning styles” was cast into doubt nearly a decade ago, students still tend to have strong opinions on what manner of learning they prefer. Given the choice, nearly all

will opt for video content over written material, thus educators should research how to effectively leverage this preference in learning aids. The goal of this study was not to replace written material with video content, but rather to use the appeal and convenience of video content to entice students to do a modicum of pre-class preparation in order to improve their in-class understanding. In future research, we intend to provide YouTube videos as an option in more technical courses at USMA to validate this current study. Also, determining any other side effects of using existing YouTube videos as educational material will prove valuable to decisions on whether we implement this practice in other courses. Moreover, other research can be done to compare the effects of using existing YouTube videos and instructor-created videos, the latter of which can be costly in time and effort but highly tailored and structured to the lecture.

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