The Impact of Lecture Presentation Medium on Student Learning

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Abstract

This research explores how the medium used to present content in an online course may impact student learning and comprehension. As Massively Open Online Courses (MOOC) become a new model for education, the impact of the medium in which content is presented may become increasingly important. This research studied whether content presented as a video is more effective at achieving student learning than the same content presented as written text. Participants were over 100 adults who received professional development training. Each participant in the study was shown one piece of content solely as video and another solely as text. There were four combinations of tests. The combinations included two pieces of content presented using two forms of media, video or text. Each participant experienced each piece of content in opposite media. After each piece of content they were asked to answer comprehension questions. Their scores on each piece of content were then compared to one another. Following the individual analysis, groups who experienced identical content (i.e. Lecture A in video) were compared to the inverse group (Lecture A in text). Data from the study is presented using bar graphs and charts detailing the comparisons. The results seemed to indicate there may be a benefit to the student's learning when experiencing content as video compared to when content is simply presented as text. As no test of significance was performed, the results cannot be generalized.

Keywords: online lecture, MOOC, presentation medium, video lecture, student learning

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Introduction

As technology evolves and the cost of services like online storage, video streaming, and broadband Internet decrease the opportunities for schools of all kinds to take advantage of new technologies increases. Where schools traditionally did not have the resources to provide video streams to students via their Learning Management System (LMS), the technology is now widely available at a relatively low cost. The question remains however, if video streaming is available for online courses, does that mean instructors should use it, and more importantly what effect does it have on student learning?

Statement of Problem

Online instruction is becoming more and more popular at institutions around the world. Thus, the determination of the most effective method of presenting content is becoming increasingly important. Instructors do not want to present their content in media that students will have difficulty adapting to or understanding.

The purpose of this study is to examine the difference in student learning when content is presented via video and when it is presented via written text.

Significance of Problem

Harvard University in cooperation with a number of top universities across the country has begun an initiative called edX. edX provides free online courses to hundreds of thousands of registrants at a time. While the presentation medium of content varies, video lectures are a significant part of a student's participation in an edX course. Other course similar to edX courses have arisen, giving rise to the term MOOC for these types of courses. According to the instructor

of the first edX course, David J. Malan, the wildly popular CS50x- Introduction to Computer Science had 150,349 students register, and of that had 100,953 active participants (This was CS50X post, para. 6, 2013).

Similarly, an organization by the name of Khan Academy provides instructional videos to students free of charge on a range of subjects from math, to history, and even computer science. The entire premise of the organization is that videos like the ones they use are more effective methods for students to learn than the traditional classroom method. To back up these claims, a 2012 report by Huffington Post blogger Eric Sheninger (2012) revealed the following statistics on Khan Academy usage, "To date, these [usage] statistics are: 140 million+ lessons delivered, 500 million+ exercises done, and 6+ million unique visits per month" (Khan Academy: Friend or Foe?, para. 1). While those statistics are impressive, and one can infer that there is obvious value in the videos that Khan Academy produces, those statistics do not explicitly reveal a direct connection between using Khan Academy and an increase in student learning.

Students all over the world are flocking to MOOCs, and sites like Khan Academy. However, the data does not exist to support the fact that student learning is impacted by the content being presented as videos over the same lecture presented as text.

Rationale

In the 21st century world, students are exposed to video on a regular basis. They watch television shows, movies, and YouTube videos regularly. Therefore, this medium comes naturally to them, and the idea of reading a book for some students is becoming more and more foreign. This would suggest that if instructors can present content in a format that students are used to and familiar with, the students' understanding of the content will increase.

If an instructor presents a student with an essay to read, the student may simply skim the text or not read it at all. They may find it difficult, or boring, and sadly, unfamiliar. If the instructor tells his/her student to go online and watch a video which teaches the same content as the text, the student may be able to easily relate to the medium in which the content is presented, and follow it more easily.

The research presented in this paper serves to inform the educational community at all levels. From the highest levels of an institution's administration which could be responsible for setting best practices and guidelines for instruction, to the individual instructor deciding how to best deliver content to students, this research is valuable. These stakeholders will find the research to be beneficial because it is not relying on gross statistics of participation which assume that retention equals comprehension. Rather, this research seeks to draw a conclusion based on true student learning results when the presentation medium differs.

Definitions

Massively-Open-Online-Course (MOOC): A Massively Open Online Course is a broad term that describes any open enrollment online course that is offered at no cost to a large number of people. Examples of MOOC providers include edX, Khan Academy, and Coursera.

Online Course: An academic course, traditionally for credit from an accredited educational institution but not always, which is taught exclusively online. This can include classes that meet via web conference as well as classes that use a Learning Management System to distribute content and assignments.

Classroom-Based Course: A course that takes place entirely in the classroom, but may include supplementary materials, or assignments posted online for students to access outside of the classroom.

Hybrid Course: A course that takes place partially in a classroom, and consists of an online portion in which students must engage with one another electronically via the web.

Learning Management System (LMS): A web-based software platform that allows instructors of an online or hybrid course to post content and for the students of that course to access the posted content. Examples of an LMS are Blackboard, Moodle, and Desire2Learn (D2L).

Video Lecture: This includes any recorded lecture that has synchronous video. This could be a recording of the instructor alone teaching the material, a recording of a white board being drawn on by the instructor, or a recorded lecture of a previously taught class.

Written (or Text-Based) Lecture/Readings: Any content or instruction that is delivered via text on a paper, or as part of an electronic file. This would include a PDF of book chapters, a journal article (electronic or otherwise), or a web site.

Cohort: A group of participants who were assigned the same form/test to take.

Period of Research: A time to be determined that will indicate when the form can be used by participants and when the form will be closed to new participants.

Research Questions and Hypotheses

Research Question 1: Is a video lecture more effective in terms of a student's comprehension of the content than a written lecture?

Research Question 2: If a difference exists between a student’s comprehension of the content, is it a direct result of the medium used to present the content?

Hypothesis: Instruction via video lecture results in greater comprehension of material than written lectures in an online format instruction.

Null Hypothesis: No difference exists in comprehension of material when content is presented as video verses text in an online format instruction.

Assumptions, Limitations and Delimitations

Several assumptions were made in preparing for and administering the study. First, it was assumed that participants (and the demographic being represented) would have Internet access, and therefore the study was advertised using online methods only. Second, it was assumed that the subject of the content was irrelevant and therefore two TED talks were selected that were on mundane and generally unfamiliar topics. Similarly, it was assumed that participants did not have any prior knowledge of the content they read and watched. Third, it was assumed that participants, once having started the study, would watch and read the full content and put forth a reasonable amount of effort to answer the comprehension questions that followed.

This paper and the included study had several limitations that were realized and properly accounted for. First, student learning and course outcomes are fairly serious metrics. Therefore, it was not possible to perform this study on an active class. The study emulated a single assignment rather than attempting to differentiate and study presentation medium in an active course. Second, due to resource constraints as well as a lack of access to active courses, it was not possible to have a massive participation in the study, and therefore the number of participants was limited.

There were also a number of delimitations that affected the study. First, in order to attract participants, the content selected for testing was relatively short, and not necessarily representative of an actual assignment in an educational setting. Second, in order to streamline the process of attracting participants and gathering consent, the study was limited to participants over the age of 18, thus meaning the study does not necessarily reflect the results that may be found in a K-12 environment. Third, as an additional method of increasing participation, the

opportunity for a reward was introduced to participants. Each participant was afforded the opportunity to include their email address prior to beginning the study to be entered into a drawing to win a Google Chromecast or Leap Motion device.

Review of Literature

The Evolution of Distance Education

The educational system of today is being transformed. In 1970, Paulo Freire spoke in his now-famous essay "The Banking Concept of Education" about the transformation that was necessary back then. Freire wrote, "Education thus becomes an act of depositing, in which the students are the depositories and the teacher is the depositor" (p. 100). Freire contends that this system is broken, and the solution is a new method called the problem-posing method (p. 106). Freire introduced the problem-posing method the following way:

> The role of the problem-posing educator is to create, together with the students, the conditions under which knowledge at the level of the doxa is superseded by true knowledge at the level of the logos. Whereas banking education anesthetizes and inhibits creative power, problem-posing education involves a constant unveiling of reality. (p. 106)

Technology in education evolved out of the invention of the personal computer. However, for many years the idea of creating computer software, not to mention more specifically, learning experiences, was limited to the relatively small percentage of programmers in the world. In his TED talk, Mitch Resnick director of the Lifelong Kindergarten group at the MIT Media Lab said, "When many people think of coding, they think of it as something that only a very narrow sub-community of people are going to be doing" (Resnick, 2012). Even consumption of that software was limited to those fortunate enough to understand the technology

and have a personal computer available. In research published by McGreal and Elliott (2004) from Athabesca University in Canada, it was suggested that, "With the evolution of more user-friendly applications and interactive content encapsulated in learning objects, one need not be a coding expert to take advantage of the learning opportunities that are becoming available on the Web" (p. 10).

Pair the evolution of education technology with access to education and said technology, and what emerges is a better educational system. As the new millennium progressed, access to technology was becoming easier to gain, and research showed the earlier a child gained access to technology, the better off he/she was. Research by Plowman, Stevenson, McPake, Stephen, and Adey (2012) said that,

> Our research on what children have learned as a result of these early home experiences with technology shows that, by the time they are ready to start school, children have developed learning with technology in the areas of acquiring operational competences, extending knowledge about and awareness of the world, developing dispositions to learn and learning about the role of technologies in everyday life and how they can be used to maintain family relationships and communication. (p. 368)

The rise of the non-traditional student. The benefits of early access to technology made children digital natives very early, and as Plowman et al. found, this allowed them to succeed in an educational setting from very early on (2012, p. 361). Research by Matkin (2012) said, "Despite the rising cost of education and the need for financial aid, a four-year degree continues to command a wage premium and a positive return on investment for students— which for many adults means further education" (p. 8). Thus, it is not enough to have digital natives in a world where the non-traditional student is becoming the majority. Characterized as age 24+,

employed full-time, and having extensive family obligations, the non-traditional student is often a part-time student taking classes online (Matkin, 2012, p. 8). Matkin (2012) also pointed out that, "Over 6.1 million students were taking at least one online course during the fall 2010 term—an increase of 560,000 students over the number reported in 2010" (as cited in Allen and Seaman, 2011).

Matkin's (2012) research went further and stated, "Online education has virtually erased geographical boundaries. National providers…have gone into the business: Most now offer online degrees, particularly at the master's level, to expand their reach beyond the borders of their traditional service areas" (p. 8). This is what is meant by "distance education". Driven by technological advances, and a strong need, distance education is fueled by a strong positive feedback loop. O'Brien, Hartshorne, Beattie, and Jordan (2012) concluded that the increased communication options were the driving force behind the expanding options for teaching and learning around the globe. Couple that with the student's desire for options, and there is significant growth in the options for teachers both in teaching and in research (p. 30). These options range significantly from strictly pedagogical options that relate directly to what is taught in the course, and various administrative or student management options that are included in many Learning Management Solutions (LMS). Olson and Wisher (2002) stated, "The flexibility of the Web enables it to be used for a variety of purposes, from course administration and management to complete course delivery" (p. 9).

With these options came the rise of the options for how courses were delivered. As an example, Matkin (2012) presented a number of options in his research such as for-profit companies like University of Phoenix, and Capella (p. 8), and organizations formed by not-for-profit institutions like Stanford and MIT that deliver open online courses (p. 9). Matkin even

mentioned alternatives to traditional degree-providing institutions as options being sought by the non-traditional student. “For instance, the Mozilla Foundation has developed a School of Webcraft, which issues badges certifying the mastery of subjects such as Javascript, HTML, and collaboration” (p. 10).

Online instruction at traditional four-year institutions. For the traditional four-year higher education institution, interested in maintaining the allure of the physical classroom, the first step in getting to the implementation of distance education was the hybrid course. O’Brien et al. (2012) concluded that, “The hybrid course emerged as strong in terms of instructional design, as the data reflected strengths in each area investigated” (p. 30). O’Brien et al. defined a hybrid course as a course, “in which instructors can opt to maximize the best of both worlds by reducing lecture time and supplementing instruction with online instruction/assessments and/or learning materials” (p. 20). O’Brien et al. (2012) found that, “For the teacher educator, having the choice of offering a hybrid course allows some options in matching content and skills to be taught in the best delivery option; this opportunity may be attractive to the teacher educator” (p. 30). By combining the great interaction of the classroom experience with the vast resources available on the Web, educators found hybrid courses to be especially useful (O'Brien, 2012).

The next step in the evolution of distance education was the fully online course. Olson and Wisher (2004) stated, “Web-based instruction…makes possible learning experiences that are open, flexible, and distributed, providing opportunities for engaging, interactive, and efficient instruction” It became possible that students from Tokyo, Japan and Washington D.C. could learn together in an efficient and meaningful way. However, what became clear early on with fully online courses was that instruction from the classroom could not just be made digital and be effective (Young, 2008, para.1-7). A number of studies and a significant amount of research was

conducted to examine the difference between the two and how to make distance education via fully online courses as effective as classroom-based courses.

Research by O'Brien et al. (2011) on teacher preparation programs found it important that "teacher preparation programs avoid getting 'caught up in the draft' of fast-moving online course development and use to the extent that the effectiveness of the learning experience does not match that of traditional, face-to-face course offerings" (p. 20). Earlier research, however, by Bonk and Kim (2006) suggested that while web-based instruction was not, by itself, as effective as classroom based instruction, there were various tactics that could improve student success. They found, "that training students to self-regulate their learning was needed most, followed by better measures of student readiness, [and] better evaluation of student achievement" (p. 26). Another finding from that same research was that subject matter expertise came third in respondents' perception of skills needed to teach online. The first response was the skill of course development, and followed by the skill of facilitation and moderation. "In effect, the results indicate that planning and moderating skills are perhaps more important than actual "teaching" or lecturing skills in online courses" (2006, p. 27).

Further data solidifying Bonk and Kim's research are included in Olson and Wisher's (2004) paper which stated, "The absence of a sturdy pedagogical underpinning for a Web-based 'instructional' program can diminish an otherwise worthy opportunity to improve learning" (p. 2). Thus, the role of course developer and moderator is again found to be more important than simply having an expert-level knowledge of the content. Along the same lines, Beattie, Spooner, Jordan, Algozzine, and Spooner (2002) found, "To be effective, distance education instructors must help remote students become part of the larger class and to "virtually" share the same instructional environment" (p. 130).

Technology in Distance Education

Technology being the driving force behind the rise of distance education, it was inevitable that it become a heavily relied on tool for effective instruction. An article by Hsiung and Deal (2013) said that, "Today, we see a new paradigm in which distance learning integrates a number of communication technologies that did not exist just a few years ago...Desktop, laptop, tablet, and smart phone handily become integral parts of distance-learning environments" (p. 36).But the merits of technology in distance education were not simply pedagogical. Enabling diverse groups of students, such as the example above of the Japanese student and the student from the United States, to study together has brought new perspectives to the educational experience. Research by Osmanoglu, Yoc, and Isiksal (2013) showed that, "when members with diverse backgrounds come together in an online environment, they can reflect on and discuss real classroom situations more effectively" (p. 1302). The varying perspectives have provided an invaluable tool for educators to gather many different perspectives on any topic. Osmanoglu et al. (2013) go further to suggest that, "Use of computer technologies makes it easier to bring members with diverse backgrounds together, and thus enriches the collaborative reflection" (p. 1302).

In addition to diversity, cost may be an important factor in the rise of distance education. The costs, or more specifically the profit margins, for an institution to provide distance courses is significantly lower than classroom classes as a result of scale. In the case of Massively-Open-Online-Courses (MOOC) the scalability of the technology may allow the institution to serve vast numbers of learners at a very low cost. An article by Marovich (2012) states that:

> The pedagogical approach of many MOOC's is bare-bones: Students watch videos of brilliant professors giving lectures, do assignments that are corrected by a digital auto-

> grader, and in rare cases engage in forums or get "real" feedback from peers in the course. Thousands of students can enroll, simultaneously, in any one of these classes. (para. 7)

Flexibility also becomes a factor when using technology for distance education. O'Brien et al. (2011) stated, "With advancements in the functionality and usability of distance education technologies offered via the web, colleges and universities have opportunities for more robust online courses in either synchronous or asynchronous formats" (p. 19).

There may be, however, drawbacks to technology in distance education. For example, Edmonds' (2006) research studying the difference between online courses and classroom based courses in identical Psychology courses found that, "Considerable retooling of delivery of content and assignments is needed for the online course to become more 'learner friendly'" (p. 19). Such "retooling" is not only necessary, but led to distinct and noticeable improvement in student performance (2006, Edmonds, p. 18). For an instructor who is unfamiliar with online instruction, or who is not capable of taking advantage of the tools available to retool a course, it is possible that he/she could do detriment to student learning in his/her course (2006, Edmonds, p. 18).

Prior research noted the tools research has found to potentially help improve student learning in online courses. Moneta's (2002) research (similar to Edmonds) indicated that, "A likely explanation to the online students' improved applied-conceptual learning…is the access to interactive graphics, practice quizzes, and short games" (p. 431).

A factor that is often missed when discussing students' ability to perform in online courses, is the learning curve associated with learning online. Edmonds (2006) stated that, "Online classes tend to require more independent work, and perhaps are actually more difficult

for students to complete and be academically successful" (p. 17). Moneta (2002) pointed out that independent work is not the only culprit. Moneta (2002) discovered that the performance drop students entering college experience due to the adjustment of lifestyle, is similarly found in the adjustment to online courses. "Students' learning curve in facing new educational technologies has a social dimension that encompasses the whole college environment" (p. 432). Moneta (2002) also found that students taking their second online course were likely to be more successful than those in their first due to the learning curve associated with online courses (p. 431).

On the same note as Moneta and Edmonds' findings that the online course is not the same as a classroom-based course, the online video lecture has been proven to be different from the classroom-based lecture beyond just the fact that it is watched online rather than live. First, in terms of effectiveness, Akiyama, Teramoto, and Kozono (2008) conducted extensive research on the online video lecture compared to the classroom-based lecture. Among their findings was the idea that different types of courses may be better suited to an online video lecture than others. Akiyama et al. used video lectures in their course that were mostly just recordings of classroom lectures. This is compared to a text-based lecture where the students would be given a reading to complete which detailed the points made in the lecture. "In the case of courses aiming primarily at transfer of knowledge…online [video] lectures seem to offer the same educational effect as conventional lectures" (p. 38). While the educational effect was the same, the student experience of the lectures was different. "Questionnaire surveys conducted among the students indicated that the online [video] lectures proved more comfortable. We also found that Web materials were highly helpful, and that the learning effect grew as the lectures were viewed repeatedly" (p. 43). In this case, the fact that the video lectures could be viewed multiple times, and on the students'

schedules, and in conjunction with other web tools, made them more effective and better-liked by the students (Akiyama, 2008).

When dealing with an online video lecture that conforms to the second definition above, there has been extensive research done to discover how content and video length translate into student learning and comprehension. Young's (2008) research revealed that many, "professors who have ventured into online education have made the same discovery: Just because 50-minute classroom sessions are the norm on a college schedule does not make that the ideal duration for students outside the lecture hall" (p. A9). These professors discovered that a student's attention span was significantly shorter when watching an online video lecture (again, which type?) than it was (at least perceived to be) in a classroom-based lecture. Young's research did not, however, reveal why this was the case.

Video in Distance Education

Beattie et al. (2002) who suggested a variable:

> The type of presentation equipment (e.g., white board "on the fly" writing, or prepared overhead material, or material developed with electronic presentation software with appropriate images to illustrate content) that the instructor uses to deliver the content is another variable that could likely effect the outcome [of a course]. (p. 131)

Video as a presentation medium in distance education became possible as a result of the rise of video streaming. According to McGreal et al. (2004), "almost any video sample with educational value can be converted to a streaming format, and many will serve as excellent additional resources on an educational Web page or for classroom courses or online courses delivered synchronously" (p. 3). This advance in video technology allowed online lectures to come about. For the first time, faculty could record their lectures, or develop separate lectures

entirely and put them online for students to consume at their own convenience. The researchers also noted that, “When implemented wisely, video can alleviate the “page-turning” boredom of many online courses” (p. 3).

Osmanoglu et al. (2013) found in their research that, “online video cases together with forum discussions have potential to create promising learning opportunities” (p. 1302). This experience can create an interaction similar to classroom based discussion while allowing for asynchronous communication (via the forum discussion) and learners all over the world to take part at their own convenience. By attempting to closely mimic the classroom experience, it is assumed that the results and outcomes in terms of student learning and comprehension can be closely mimicked as well.

The future is bright for online video lectures. Quillen’s (2013) research found that, “Some content providers…have found that as more of their consumers become familiar with creating their own videos through apps and mobile devices, they are more forgiving of lower production values, as long as the informational value doesn't lag” (p. S8). This indicates that the creation and use of lower quality videos as educational content is becoming acceptable. No longer does one need a television studio to create educational content. Anyone, anywhere, any time can create content worthy of the classroom. According to Quillen (2013):

> The future possibilities for educational video may lie far beyond how the medium can more effectively deliver content to students. The cameras and apps available on smartphones and tablets are already making possible the ability for students to conduct video analysis out in the field, especially in science subjects such as physics and biology. (p. S10)

Summary

While prior research may indicate the technological future of online video lectures is bright, it is not yet been researched as to how effective, if at all, online video lectures can be over their competitor, the written online lecture. It appears from the research that courses containing online video lectures can be effective, research on the magnitude of effectiveness specific to the video content is lacking. Research to determine the specific difference in effectiveness between lectures presented as text and lectures presented as video is lacking at this point in time.

Methods

Consent and Ethics

In order to gather consent, the participants for this study were asked to click on the link to open the survey only if they were over the age of 18. This certification appeared on the front page of the study saying, "By clicking the link below you certify that you are above 18 years old." Because all of the participants were over the age of 18, no parental consent was needed.

Participants

Requirements for participation were simply that the participant be over the age of 18. The research was targeted at anyone eligible to take a Massively-Open-Online-Course (MOOC) and since that, by definition, applies to the general public there were no demographic requirements other than that the participants be over the age of 18. In total, over 100 participants submitted responses to the four different surveys.

Participants were solicited using a variety of methods, most of which involved social media. Participants were asked to take part in the survey using the following means:

1. Advertising on Facebook
    a. Targets groups for the ads were Facebook users including:

i. Who live in the United States
ii. age exactly 18 and older
iii. Who like #Khan Academy, #MIT OpenCourseWare, education, #Udemy, #Massive open online course, #Coursera or #EdX
iv. on Right column on desktop computers
v. Who are in the broad categories Education/Teaching or Educational Software

b. This target allowed for a possible reach of approximately 1.38 million people.
c. I also made several posts to friends of mine via status updates

Advertising on Bing

a. Keywords targeted on Bing:
    i. Online courses
    ii. Video
    iii. Higher Education
    iv. Framingham State University
    v. Educational Research
    vi. Google Chromecast
    vii. Instructional Methods
    viii. Instructional Technology
    ix. Leap Motion
    x. Massively-Open-Online-Courses

Google+ Communities

   a. Participation was solicited in the following Google+ Communities via a custom post:
      i. Chromecast
      ii. Massively-Open-Online-Courses
      iii. Educational Technology
      iv. Google Drive & Google Docs
   b. In addition, generic pleas were made to family and friends in my circles.
4. Other social media
   a. I advertised for the survey on Meetup.com in the Boston EdTech group
   b. I made several pleas on Twitter from both my username which has about 103 followers and using my company's Twitter account which has over 80 followers.

Additionally, when advertising for participants to take the survey, they were offered a chance to win either a Google Chromecast ($35 value) or a Leap Motion Controller ($80 value). This incentive was determined to be appropriate since it was unlikely to cause any of the participants to take any greater risks in the study than they would have without an incentive.

Instrumentation

A web application was created in order to collect certification that participants were over the age of 18 and in order to randomize the particular test that each participant would take. This web application was in the form of a webpage that the researcher directed willing participants to. Upon arriving at the web page, without the participant's knowledge, a JavaScript code assigned one of four Google Forms to the participant. The participants provided consent to being over 18 by clicking on the link.

The four Google Forms (tests) were structured in the following way:

Test	Step 1	Step 2	Step 3	Step 4
Test 1a	Text of Lecture 1	Comprehension Questions	Video of Lecture 2	Comprehension Questions
Test 1b	Text of Lecture 2	Comprehension Questions	Text of Lecture 1	Comprehension Questions
Test 2a	Video of Lecture 1	Comprehension Questions	Video of Lecture 2	Comprehension Questions
Test 2b	Video of Lecture 2	Comprehension Questions	Text of Lecture 1	Comprehension Questions

(Table 1.1)

Due to the random assignment, at least 25 participants took each of the 4 tests.

Procedures

Test Development

1. The researcher selected 2 unrelated and insignificant lectures from TED.com to present to the participants.
2. The text of each lecture was copied and the link to embed the videos was noted.
3. Five comprehension questions were selected for each of the lectures.
4. Four Google Forms were created and the content was added according to the setup laid out in Table 1.1.

Web Application Development

1. A web site was created to which participants could be directed.
2. Welcome text was added and the age of majority agreement was added to the web page.
3. A link for the participant to click was added.
4. A JavaScript formula was written which randomized the URL behind the link on the web page to direct participants to one of the four tests.
    1. The JavaScript formula was as follows:

       (Italicized text preceded by // is commentary offered by the researcher to explain the formula. It has no effect on the program.)

```
// Set the function to be called on the web site.
function siteAssignment() {
// Set the variable URL and generate a random number between 0 and
1, then multiply it by 4 and round down.

   var url = Math.floor(Math.random() * 4);

// Print the random whole number in the console.
   console.log(url);

// If/Else statement
// If the value of URL is equal to 0 assign the URL for the first
test to the variable "url".

   if (url === 0) {
       url =
"https://docs.google.com/forms/d/1IZtKjgF1QRe9nfyeRl_AfMkf4e7x8mGN
_KJfg3D-Xp8/viewform";

// If the value of URL is equal to 1 assign the URL for the second
test to the variable "url".

   } else if (url === 1) {
       url = "https://docs.google.com/forms/d/1zduehZmOCE4-
tINw_Jb_v2utU1sEQhZYuKqJ9QM7B00/viewform";

// If the value of URL is equal to 2 assign the URL for the third
test to the variable "url".

   } else if (url === 2) {
       url =
"https://docs.google.com/forms/d/1gPabchlBKms08GxoxOJoZdWTUIM3uNka
2bFZMwaqM1o/viewform";

// If the value of URL is not equal to 0, 1, or 2 (aka it is 3)
assign the URL for the fourth test to the variable "url".

   } else {
       url =
"https://docs.google.com/forms/d/1bRRvdebkxiLTtkB9PVAOzdijuBFhJHXZ
-Lo9PGNHVqc/viewform";
   }

//Return the value of the variable "url" for use in the link on
the web page.

   return url;
}
```

Data Analysis:

The first step is to determine whether the order in which the content was presented played a role in a participants understanding of the content. In order to do this, the number of wrong answers for the first piece of content that a participant experienced were combined, regardless of medium. Then, the same was done for the second piece of content that a participant experienced, again, regardless of medium. Then, the two numbers were compared to determine the disparity, if any, between when content was presented first or second. The larger the disparity, the more of an indication that sequence played a role in the previous findings regarding presentation medium.

Example:

Referring back to Table 1.1, all of the wrong answer totals for the content in Step 2 were combined. They were then compared to the number of wrong answers for all four tests in Step 4. The two numbers were then combined to indicate a degree of disparity between content shown first and content shown second.

The next determination is the most important. Assuming that the sequence in which content was presented did not play a significant role in the participant's understanding of content, the next step is to determine which medium, if any, was more effective. Analysis began by matching content/medium pairs to be isolated and analyzed for the total number of wrong answers. Once all pairs were combined and totaled, the matching medium scores were combined to form a score for that medium. This score formed the total number of wrong answers for all lectures of one medium. This was then repeated for the opposite medium. The two scores were compared, and whichever had the least number of wrong answers was the more effective medium in this study.

Example:

Test 1a and Test 2b both showed the Text of Lecture 1. Therefore, the total number of wrong answers will be calculated. Those scores will be added to form the score of the Text of Lecture 1. Then, that score will be combined with the total score for the Text of Lecture 2. These two scores are compared to find the more effective medium.

Data was then summarized and bar graphs and charts were created to showcase the data and show the results of the study.

Bias

It's possible that there was a bias in individuals that favored videos instead of text. Some participants indicated that they didn't even read the text because it was too long. However, this bias serves to prove the hypothesis as students in the same situation may react in exactly the same way.

Assumptions

The assumption was made that participants did not use the back button in the survey to return to the content and check it for the answers to the comprehension questions.

Limitations

There was a budgetary limitation on this study. The paid advertising for Facebook and Bing proved to be very helpful, but it was also expensive. Should there have been more funds available, more advertising could have been done, and more participants could have participated.

Additionally, in order to maintain the same number of participants that took each test when doing the data analysis, the researcher took the test with the smallest number of participants and eliminated results for any number of participants over that minimum number in the other three tests.

Delimitations

Because there was not an unlimited budget, a goal of 100 participants was instituted. The survey was available for approximately two weeks. In that time, it took a significant amount of work to get to 100 participants, but that was necessary in order for the results to be valid.

Results

Research Question 1: Is a video lecture more effective in terms of a student's comprehension of the content than a written lecture?

Research Question 2: If a difference exists between a student's comprehension of the content, is it a direct result of the medium used to present the content?

Hypothesis: Instruction via video lecture results in greater comprehension of material than written lectures in an online format instruction.

Null Hypothesis: No difference exists in comprehension of material when content is presented as video verses text in an online format instruction.

The research found that a video lecture is not significantly more effective in terms of a student's comprehension of the content than a written lecture. In total, 135 participants took the survey. 2 of the surveys had additional participants totaling 7, which were eliminated so that the total participants per survey was equal at 32. Once the total participants per survey were equal, the number of wrong answers per question was determined. This provided a raw score for each of the two segments of the four tests, eight in total.

The raw scores for each segment were as follows:

(In all tables, Lecture 1 is referred to as Walking, and Lecture 2 is referred to as Story simply representing the content of the lectures.)

Test	Wrong Answers
1a-Text-Walking	40
1a-Video-Story	21
1b-Text-Story	33
1b-Video-Walking	49
2a-Video-Walking	47
2a-Text-Story	36
2b-Story-Video	32
2b-Walk-Text	45

(Table 1.2)

First, it was necessary to determine whether the order in which the content was presented affected the number of wrong answers. Table 1.3 shows the raw data for this analysis:

	1A	1B	2A	2B	Wrong Answers	Combined Totals	Difference
Walking First:	40		47		**87**	**152**	**1**
Story First:		33		32	**65**		
Walking Second:		49		45	**94**	**151**	
Story Second:	21		36		**57**		

(Table 1.3)

From this data we can conclude that since the difference between content presented first and content presented second was just 1 wrong answer, the sequence was not relevant in determining student comprehension.

Next, the appropriate scores were combined to draw the relevant conclusions.

	1A	1B	2A	2B	Wrong Answers	Combined Totals	Difference
Story/Text		33	36		**69**	**154**	**5**
Walking/Text	40			45	**85**		
Walking/Video		49	47		**96**	**149**	
Story/Video	21			32	**53**		

(Table 1.4)

Table 1.4 shows that for both lectures presented as text the total number of wrong answers was 154. For both lectures presented as video the total was 149. This data presented two findings. One, that text had more wrong answers and was therefore less effective than video. However, the data also showed that the difference was only five wrong answers. This indicates that there was not a significant difference between the two media. These findings are summarized in charts 1.1 and 1.2 below.

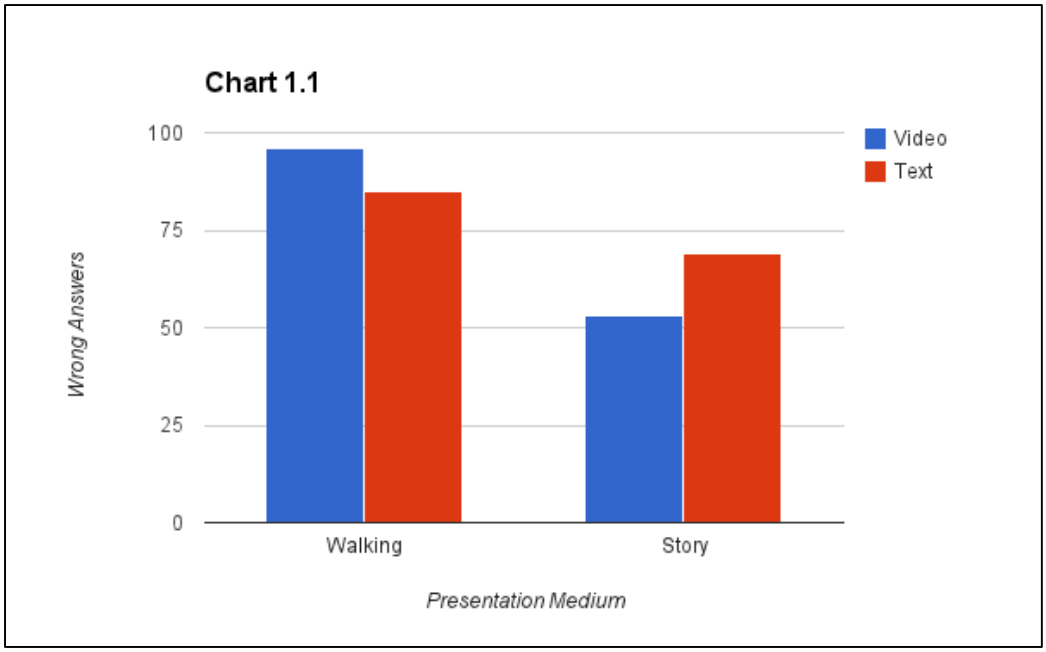

Chart 1.1 depicts the small disparity between content presented as text and content presented as video.

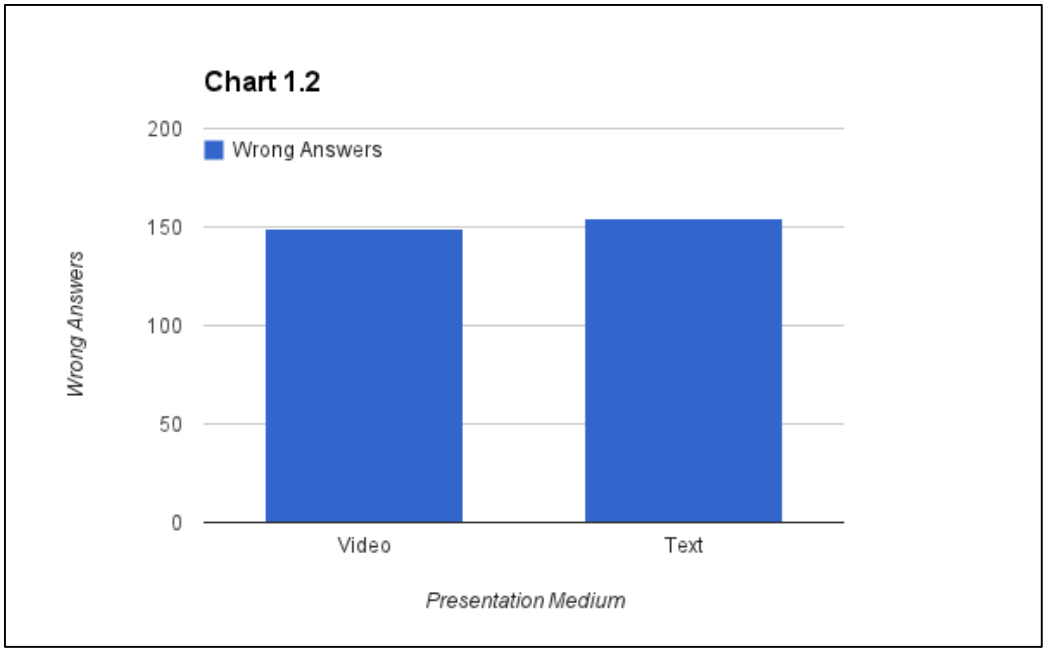

Chart 1. 2 depicts the two different pieces of content and the disparity for each one. Note that Walking saw more wrong answers when presented as video, and Story saw more wrong answers when presented as text. This lends further credibility to the finding that there is no relationship between presentation medium and wrong answers and thus student learning.

Due to the fact that only 132 submissions were analyzed, these results cannot be generalized.

Discussion

The data revealed by the study shows that presentation medium, at least as far as text and video are concerned, does not seem to matter much. The data do, however, reveal a potential disparity with the difference of five wrong answers. Further research could be done using content that is more similar to an actual lecture. For example, research could be done using longer content. This study may show that students are willing to put up with a small piece of text, but further research could use a twenty minute video, and the transcript of it, in order to determine if

there is a point at which length affects the effectiveness of video over text. Additionally, further research would be best if it analyzed a greater sample size.

Ultimately, the results are surprising, and even tempt further research. In fact further research could be even more helpful by determining how long a text lecture can be before losing the interest of students and making video more effective. It is, in the end, entirely possible that there is no difference between the two media. However, it would take more research in order to be convincing.

As education moves forward with online, and distance education, this research will be important. Further, as more presentation media like slide presentations, interactive whiteboard presentations, and interactive chat sessions evolve and become commonplace in courses, those media should be factored in to see which is most effective. In fact, there may be a medium that develops in the future which no one can even imagine today. Therefore, this research should not be seen as definitive and generalizable, but rather point to even further, ongoing research in this area to be able to eventually pinpoint the medium that is most effective for students.

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