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Measuring the Effectiveness of Online Lectures through Online Pre-Tests and Post-Tests

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Abstract: The amount of material which is to be covered in introductory physics courses is extreme. Traditional lecture presentations have become inadequate to keep up with the pace. Professors of physics are often left with the difficult task of trimming the list of topics to be covered or increasing the amount of information presented each lecture. Neither of these options seem acceptable. A third alternative would be to flip the classroom by providing the students with prerecorded online, video lectures which the students can watch individually. This can free up time during the lecture period for use in guided problem solving and collaborative activities. The Physics for Life Sciences course at the Richard Stockton College of NJ was flipped by providing the students (N = 40) with online video lectures for three topics. The effectiveness of each lecture was measured by using a pre-test and a post-test.

Key words: flipped classroom techniques, video lectures, assessment

1. Introduction

1.1 Introduction to Flipping the Classroom in the Physics for Life Sciences Course

In the Physics for the Life Sciences I and II courses, there is a broad range of important foundational topics that are necessary pre-requisites for understanding later concepts, as well as a broad range of interesting topics, and time is often a limiting factor in deciding how to apportion the instructional emphasis between these concepts and topics. Many students, including the students who have both a strong desire to understand the concepts and a strong foundation in the mathematical techniques needed to apply the concepts, find themselves overwhelmed by the volume of material covered in lecture.

One solution to this problem is for the instructor to selectively trim the list of topics. The decisions as to which topics to trim can be easy decisions if all of the students in the class come from the same program (or major). For example, for a class of pre-med students, the topic on reinforced concrete may be optional, whereas it is not an optional topic for a class of architectural students. If the class has students from a diverse range of programs, the task of trimming becomes daunting. The instructor may find some comfort in giving as an assignment to the students to read the chapter, but a recent study completed in the Richard Stockton College of NJ

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Physics Program, using a self-reporting survey, shows that the amount of the text being read by the students is minimal, if the text is being read at all.

A second solution can be found in “classroom flipping” techniques, such as online video assignments. Although there may be some argument as to the quality of a degree completed entirely online, very few educators would find fault with the concept that online components can be used to enhance a lecture course. Online components to lecture and laboratory based instruction have been used very effectively in industry and research. Examples of enhancing education by using online components can be found at Sun Microsystems, Inc. (acquired by Oraclein 2010) and the National Center for Atmospheric Research, who required attendees of workshops, and instructor lead courses, to complete an online tutorial prior to attendance at the workshops and courses. These online components consisted of tutorials that covered background material, such as basic concepts that the scientists and engineers would be expected to be familiar with prior to the course, along with new terminology that would be used during the workshop or course. The online components reduced the amount of time needed by the instructor to cover background material and the attendees were prepped to acquire the important concepts to be covered in the course.

In the introductory physics courses, using online videos that the students watch independently, outside of class, can have many desirable consequences. First, the students can have the opportunity to take responsibility for their education and learn to be independent. Second, time spent introducing topics in the lecture period, can be more effectively used working on problem solving and other activities. Third, the recorded lectures can be viewed many times and used by the students to prepare for exams.

2. Review of the Literature

This section offers a review of the literature related to the reasons why to flip the classroom and techniques used to flip the classroom. There are many ways to flip a classroom, but one of the most common methods is to have students watch a recorded lecture as homework and use the lecture period or the time in class as a problem solving session or a time for intensified instruction on concepts or techniques that have presented obstacle to student learning.

2.1 Reasons to Flip the Introductory Science Classroom

Techniques for “flipping the classroom” are not completely new techniques to teaching. Renewed interest in the techniques involved in flipping the classroom seems to come from a “convergence of several trends” as discussed by Berret in his article “How Flipping the Classroom Can Improve the Traditional Lecture”. First, there has been a wave of technological innovations in teaching, allowing for high quality recording of lectures and impressive creation of online tutorials. Second, the policymakers, who desire improvements in education, are requiring evidence that the students are truly learning the material taught through new methods or enhanced techniques. Third, the forces of the economic reality are driving creative ways to use time and money more efficiently (Berret, 2012).

There are many reasons to flip the physics classroom. The main reason for flipping a classroom is to maximize the effectiveness of the time provided for lecture. If the student watches a recorded video at home, the time spend in the classroom can be used more effectively (DeMaio, 2014). The instructor can assign the video to be watched outside the classroom. After the video is watched, the instructor can use the time spent inside the classroom working on problem areas or difficult topics. The instructor can discover the problem areas by

surveying the students or with the help of quizzes or short tests. Clickers can also be used to gain insight into the effectiveness of a teaching technique or lecture (Mejerich, 2011; Willoughby, 2009).

The flipped classroom techniques have many advantages. When video lectures are used, as the student watches the video, the student can stop and rewind the lecture at will. When a topic or concept is not perfectly clear to the student, the student can review the section of the video instantly. The student can also use the video lectures to study for the exams (Riendeau, 2012).

Videos can be used to record demonstrations and exhibits. The use of videos means that every student has a front row seat to the demonstrations (Riismandel, 2013). The students can freeze and replay the videos. The objects in the videos can be shown as close-ups which can greatly enhance the demonstrations. Although having all demonstrations and exhibits recorded and presented as videos would be extreme, as there is definitely advantages to live demonstrations, having a portion of the demonstrations presented as videos would be advantageous. The videos can be easily paused, replayed and ran in slow motion. For example, physicists using demonstrations involving projectile motion, such as the “hunter and the monkey”, can be quickly shown using different initial conditions for the launch angle and the initial speed of the projectile. Slow motion can be used to show the path of the projectile. Biologists can use a video to present a model of the heart. Close-ups of the different parts can be much more effective than the presentation in a traditional lecture format where the lecturer uses a model of the heart in front of a large group of students.

Some researchers and educators feel that the use of the flipped classroom leads to students who become more independent thinkers (Elmore, 2011). It is up to the student to gain the required knowledge through watching videos or reading texts. The success of these flipping methods depends on the students acting responsively and doing independent work outside the classroom. If the students complete the assignments, the time in class can be spent deepening the understanding of the topics covered outside class and eliminating any misconceptions reached during the watching of the videos.

Siegle sums up the concepts behind and the advantages in the use of flipped classroom techniques in the article concerning teaching gifted and highly talented students. “Classes become the place to work through problems, advanced concepts, and engage in collaborative learning. Most importantly all aspects of instruction can be rethought to maximize the scarcest resource — time.” (Siegle, 2014)

2.2 Methods Used to Flip the Introductory Science Classroom

When most educators hear the term “flipped classroom”, it commonly associated with the use of technology and recorded lectures. The concept of flipping the classroom is appropriate to categorize any procedure where the instructor relinquishes control and uses methods in which the students teach themselves or each other (Hendee, 2007). Techniques for flipping the classroom usually requires the students to do some activity outside the classroom in preparation for the learning activities conducted inside the classroom.

One method is to have the students read a lesson, watch a video, or complete an online tutorial. The students then come to class and complete some group activity or work on problem solving techniques. De Maio, in a medical imaging course, used short fifteen to twenty minute screencasts which the students watched prior to coming to class. The term screencasts refers to the video capture of an entire screen while software is in use, accompanied by audio narration. When the students came to class, they then worked individually or collaboratively on sample problems. The screencasts were kept to fifteen or twenty minutes to make the content manageable and to keep the students attention (DeMaio, 2014).

Educators may find it difficult to find the time to create the videos that are used outside of the class time. First the educator must learn the techniques needed to capture the lectures or presentations. The educator must then take the time to record the video. It is not uncommon for a video to require editing or for several attempts to be made to create an acceptable video. For this reason, some educator use videos or tutorials that have already been created. For example, YouTube videos (Riendeau, 2012) can found that are very well made and present the concepts quite well. Prepared online tutorials, such as those found on Lynda.com, can also be used effectively for some subjects (Baker, 2013). Many educators can find that after attending a short course found in the computer bootcamps offered by many universities, they can become proficient in the use of software such as Camtasia or CamStudio, and can quickly produce videos of an acceptable quality.

In summary, the techniques involved in flipping the classroom normally consist of a homework assignment to read on a topic or concept or watch a recorded video on the topic or concept. The learning takes place outside the classroom and it is the student's responsibility to gain the required knowledge. The class time is used to work independently or in collaboration on problem solving and other activities, with guidance and help from the instructor.

3. Methodology

3.1 Materials and Method

In one section of the Fall 2013 semester of the Physics for the Life Sciences I course, three online video lectures were used to cover topics that lent themselves to an online format. The topics were: (1) Fluids (2) Temperature and (3) Heat. The lectures covered the introduction to these topics, definition of terms used, presentation of basic equations needed, and some simple applications of the equations. The video lectures were recorded using Camtasia Software and consisted of a power point presentation with a voice-over lecture component. The voice-over lecture component consisted of Microsoft PowerPoint slides that were narrated using Camtasia Studio PowerPoint Add-in. The videos were thirty to forty-five minutes in length. The lectures were made available on the Blackboard website. The lecture on fluids covered density, states of matter, and pressure at a depth. The topics covered in the temperature lecture included the different temperature scales, conversions between the scales, and the kinetic theory of temperature. The lecture on heat covered the very basics of the units used, thermal expansion and methods of heat transfer.

4. Assessment and Results

4.1 Discussion of the Method Used for Assessment

To assess the success of the video lectures, a ten question, online pre-test and post-test were completed for each of the three topics. The students were instructed to take the online pre-test, watch the lecture, and complete the online post-test. Seven of the questions were conceptually based and three were simple quantitative questions. The students received credit for completing the tests, but the actual scores on the tests were not used in the computation of the students' grades. Even though the actual grades were not used in the computation of the students' final course grade, the students seemed enthusiastic to do well and learn the material.

4.2 Results

A graph of the difference between the post-test score and per-test scores is shown in Figure 1. For all three

topics post-test scores were higher on the average than pre-test scores. The average increase of 11.8 points for the topic of Fluids, an average increase in grades of 9.7 points for the topic of Temperature, and an average increase in grades of 11.8 points for the topic of Heat. The average pre-test scores were 56.7, 79.7 and 61.8 for the Fluids, Temperature and Heat. Not surprisingly, the lower the average pre-test score, the greater the average increase in the scores. This can be seen in Figure 2 which shows that the lower the average pre-test score, the greater the increase in post-score tests can be. Histograms of the pre-test and post-test scores are shown in Figure 3.

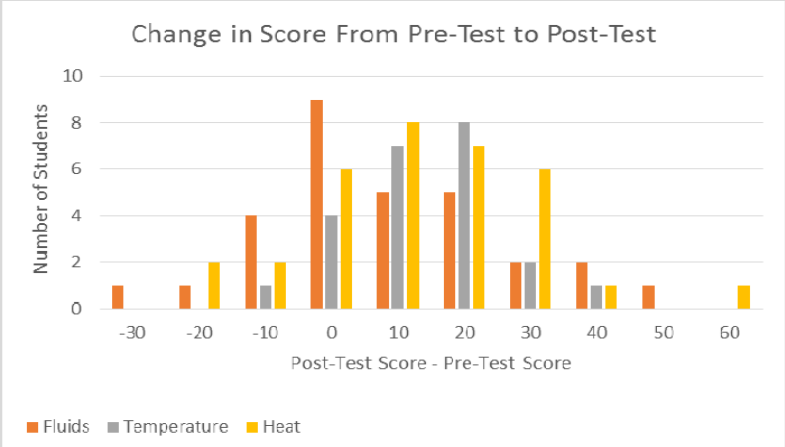

Figure 1 A Graph of the Post-Test Score Minus the Pre-Test Score for the Three Topics Covered by Online Lectures

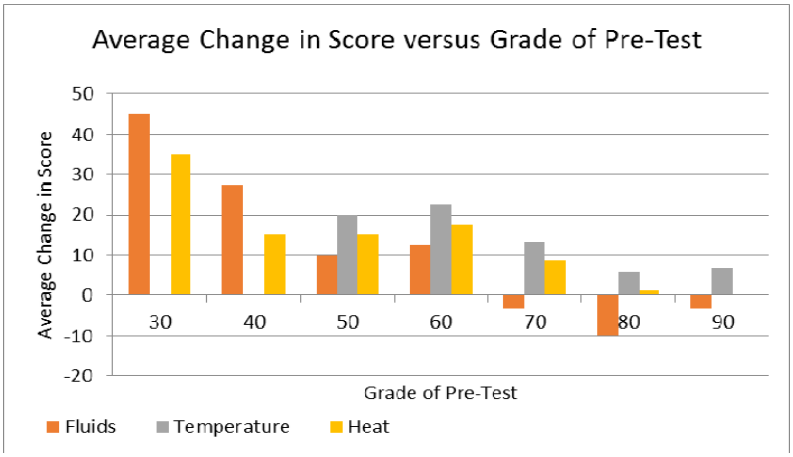

Figure 2 A Graph of the Average Change in Score Versus Pre-Test Grade

Note that the topic of temperature had the highest increase in scores. Of the three topics, this topic was the most compatible with the online format. The topics in this lecture were straightforward and the graphics available for the online video lecture were very useful.

The graphs in Figure 1 and Figure 2 also shows that a number of students received lower scores after watching the video lecture for fluids. Although this information is disheartening, it can be used to improve the lectures and used to correct misconceptions during the normal instructional cycle. It should be noted that although the lecture on fluids lends itself well to a video format, it covered the most diverse topics and ran for the longer time period, which might explain the lower grades after viewing the lecture. After the scores were analyzed, the decision was made to reformat the lecture on Fluids into two shorter lectures.

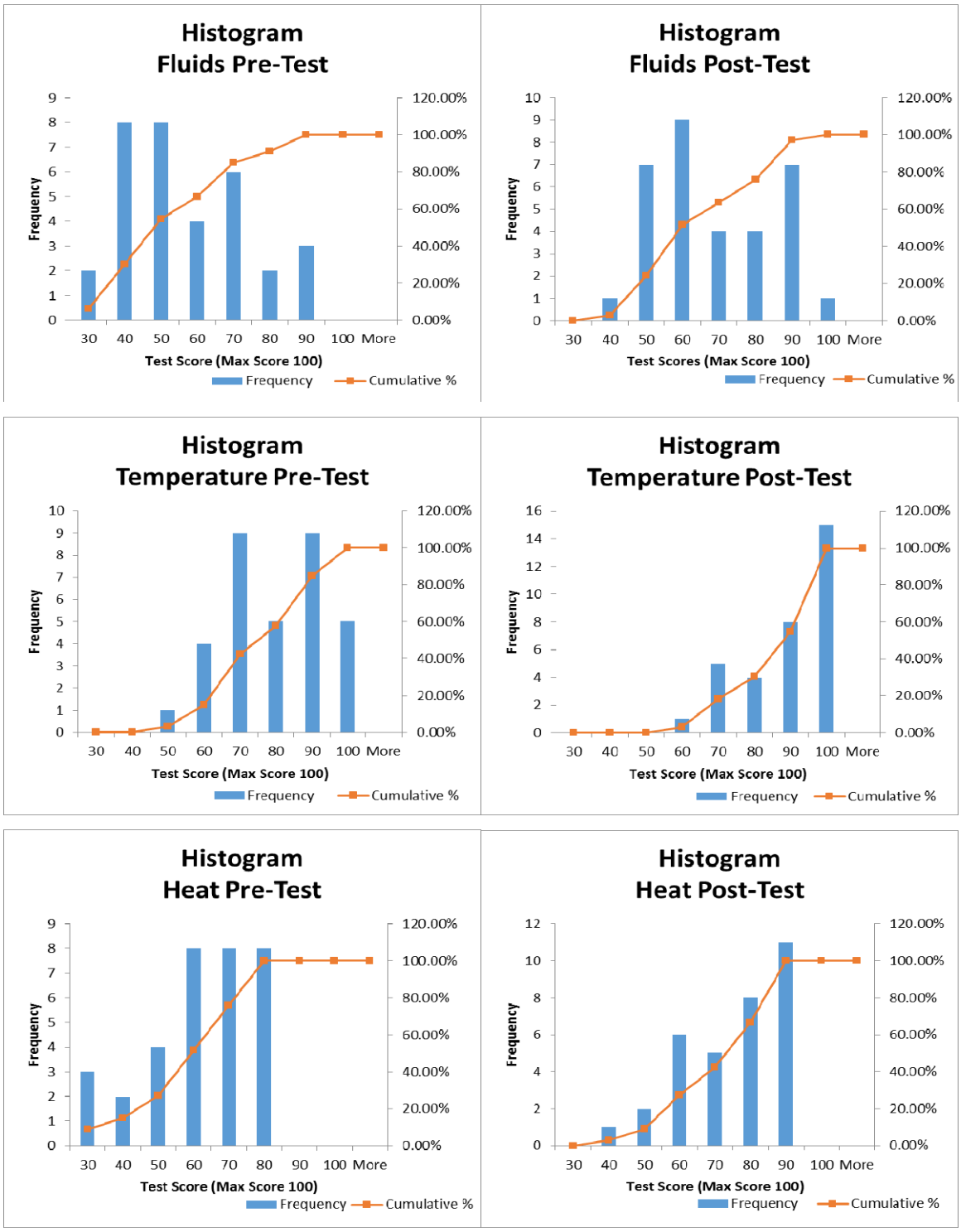

Figure 3 Histograms of Student Scores in the Pre-Test and Post-Test

In summary, this study shows that the online lectures can be an effective method to enhance lecture courses. In general, the students increased their scores after watching the video lectures. The results from the tests were used to help direct the lectures and clean up misconceptions.

5. Discussion and Conclusion

In this study, the introductory physics course, Physics for Life Science I, was flipped by having the students watch an online video outside of class time and using the in class time to work on problem solving techniques. The effectiveness of the videos were tested by having the students complete a pre-test prior to watching the video and complete a post-test after watching the video. From the increase in test scores, it appears that the videos were successful. This study provides evidence that the videos are effective and should be continued. The videos that were created were used to introduce the chapters, presenting definitions and basic concepts. With the use of these videos, time normally spent on these topics in lecture could be reapportioned to an application of concepts, problem solving and deeper investigation of the topics.

In the future, the video recording will be kept to twenty or twenty-five minutes and more videos created. With a shorter time frame, fewer topics will be presented in a deeper format. This will be easier on the students which will be able to concentrate better during a shorter time frame.

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