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An Archival-based Flipped Classroom Implementation for Enhancing the Performance of Academically Struggling Students

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Abstract: Tuskegee University (TU) has a special status in Aerospace Engineering and shoulders a significant responsibility of graduating the most African-Americans in Aerospace Engineering across the United States. Due to its established credibility, the program/university recruits aspirants from across the nation but particularly so from states in and around its own. Quite often, the aspirants seeking a career in Aerospace Engineering are under prepared as freshman and it carries over even as juniors and seniors. To maximize the chances of graduation for these underprepared students, several courses are offered during both Fall and Spring semesters. The author has made a conscious attempt of archiving the lectures as videos with the intent to facilitate revision of the material presented in class. In an experimental offering of a course in Aerospace Engineering, the author implemented a flipped model based on the archives created over several years. The article discusses the process of creating the archive, processing the archives to created video snippets for flipped classroom model and its impact on the participants.

Keywords: Flipped classroom, Archival education, Under prepared students, YouTube archives y

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1. Introduction

It's been repeatedly acknowledged by industry, government and academic institutions that science, technology, engineering and mathematics (STEM) workforce development is a top concern and is crucial for progressing U.S. economy and standard of living [1]. One of the major thrust areas in addressing the STEM workforce development has been to increase the representation of under-represented communities like African-American and in particular, African-American women [1]. The Historically Black Colleges and Universities (HBCUs), although chronically underfunded [2], have been largely responsible for addressing the STEM workforce disparity among Black aspirants [2, 3]. Although, the burden on HBCUs for addressing workforce disparity is overwhelming, the STEM initiatives undertaken by them may be the most impactful in addressing this concern [2]. Tuskegee University (TU), one of the most recognized HBCUs in the U.S. [4], admits a significant population of Black STEM aspirants; particularly from AAA and its neighboring states. In an attempt to address the workforce disparity and nurture an environment for a productive livelihood, TU recruits high school graduates with varying prep in STEM. As a consequence of this practice, the STEM faculty at TU; particularly in the College of Engineering; are faced with the challenge of educating under-prepared students to be exceptional leaders and high-class engineers in the society. Although challenging, TU has performed commendably as an HBCU and has been recognized

for its contributions [4]. By far, the limited prep is the most significant challenge, which students discover during their program and it rolls over to the faculty as a challenge to find novel, effective and efficient methods to re-teach some of the material as they progress through the program.

2. Need for Archival-based Flipped Classroom

Although, engineering is inherent in the universe, it can be challenging to develop an engineering perception. Such a challenge can transition to perceiving the engineering world and is amply evident in a majority of the incoming freshmen at Aerospace Engineering of TU. A significant fraction of incoming freshman, sophomores and even the higher classmen (juniors & seniors) face a daunting task of maintaining grades in their programs largely due to this challenge. Although, many of them are able to demonstrate commendable effort, their limitation in comprehending the material in a single classroom sitting limits their ability to demonstrate their competency, significantly. Engineering at its core is largely applied mathematics and physics. A good engineer is one who can look at a real-world problem, translate it to an engineering problem, apply the principles of physics & mathematics to formulate & seek an engineering solution and perceive it in the real world. The following stages are fundamental to any engineering discipline and focus of any engineering program:

1. Perceive a real-world problem as an engineering problem

2. Apply the laws of physics to formulate the engineering problem as a mathematics expression

3. Seek a mathematics solution by applying engineering mathematics

(a) Solution to differential equations (ODEs, PDEs, etc.).

(b) Solution to an algebraic equation

(c) Solution to a geometric equation

4. Simulate and analyze the solution in real-time to obtain a static/dynamic graphical representation (graphs, plot, distribution, mechanical/electrical designs).

5. Interpret the mathematical solution and simulation results in real world.

6. Prototype the solution and demonstrate functioning.

For several years now, the author is offering courses in Aerospace Engineering and two of them are core theory-based courses, which need to be taken by every student in the program. At large, the material presented in these courses is foundational and has very limited variations. To facilitate the student to review the material presented in class, the author would use a simple webcam and a Bluetooth based microphone to record the lectures as videos and upload them on YouTube. Over the years, the quality of the webcam has increased significantly and there isn't a need for a Bluetooth microphone. In one of the most recent semesters, the course was to be offered to just four students, so they could have an opportunity to graduate. The author made a flipped style offering of the course along with incentives to watch and comment on the videos processed for the offering. Due to the videos being uploaded on YouTube, the author could use the tools provided by the application to carve out videos convenient for the class participants. It was quite obvious that the participants benefitted from the offering, but it was even more encouraging that the students developed a better understanding of the material. It was also evident that the students preferred a more animated presentation of the material as opposed to a practiced, mundane reading of the material on a webcam.

3. Course Objectives and Grading Breakdown

A course in Automatic Flight Controls, which is a core course for the students in the Aerospace Engineering program at TU, is traditionally offered in Spring semesters but needed to be offered in the Fall semesters. As mentioned previously, the underlying intent of the offering was to facilitate students to graduate and provide another opportunity for those repeating the course. Moreover, it was observed that 75% of the course participants had failed in at least one similar offering and supplementing the traditional pedagogy was a critical need. In the context of ABET accreditation [5], the following objectives were sought:

- Describe the advantages and disadvantages of feedback control systems (ABET a, h)

- Mathematically model simple dynamic systems sets of differential equations (ABET a, e)
- Use industry standard metrics to characterize the time response of first and second order systems (ABET a, e)
- Determine the stability of a system over a range of gains (ABET a, e)
- Calculate the steady-state error of a system's response to standard test inputs (ABET a, e)
- Design a feed-forward controller to meet transient response and steady-state error specifications (ABET a, c, e, k)
- As a result of this course, the following ABET student outcomes would be achieved:
- Apply knowledge of math, science and engineering – ABET a
- Design a system, component or process to meet desired needs – ABET c
- Identify, formulate and solve engineering problems – ABET e
- Broad education necessary to understand the impact of engineering solutions in a global and societal context – ABET h
- Use the techniques, skills & modern engineering tools necessary for engineering practice – ABET k
- It was critical to adopt a grading breakdown, which would encourage the participants to watch the assigned videos, more than once, whenever necessary. Accordingly, the following grading breakdown was adopted:

1. Homework/Quizzes:	30%
2. 2 Tests (10% each)	20%
3. Midterm	15%
4. Final Exam	15%
5. Online video review confirmation	10%
6. Attendance	10%

4. Course Implementation, Results and Assessment

When the expectations of the course were discussed in class and the proposed provision was communicated, many of them were welcoming. At the beginning, it was felt that the participants may perceive the proposed approach in two ways – (i) Use it as an opportunity to develop a better understanding of the material or (ii) Use it as an excuse for one's lack of effort. To assess the impact of the archival-based flipped classroom approach, a survey was conducted. As part of the survey, the following questions were posed to the participants:

1) Do you watch the assigned videos on time (Choose one)?

a) Always

b) Most of the time

c) Never

d) Rarely

e) Some of the time

2) Does watching videos help you understand the material, better (Choose one)?

a) Extremely confident

b) Somewhat confident

c) It helps

d) Doesn't matter

3) What is the length of the video you prefer for credible value addition (Choose one)?

a) 15-20 mins

b) 20-30 mins

c) 30-45 mins

d) Others (Specify)

4) How likely are you to watch the videos if points/grades are allocated (Choose one)?

a) Very likely

b) Likely

c) Doesn't matter

d) I'll watch knowing inherently it'll up my grade.

5) How likely are you to watch the videos if data shows that being prepared before coming to class will up your grade by one letter (Choose one)?

a) Very likely

b) Likely

c) Doesn't matter

d) I'll watch knowing inherently it'll up my grade.

6) Would you come to class if all the videos were made available online (Choose one)?

a) Yes

b) Not really

c) Depends on the instructor

d) Doesn't matter

7) Describe the effort you have put in during your time AT HOME (Choose one)?

a) I try hard.

b) I don't do much at home.

c) Only when a HW/Exam is due.

8) Describe the effort you have put in during your time IN CLASS (Choose one)?

a) I try hard.

b) I come to class for attendance.

c) It depends on the class

9) What is the MOST HELPFUL part of watching assigned videos (Describe)?

10) What is the MOST NON-HELPFUL part of watching assigned videos (Describe)?

The scale used for assessing the participants' timely action in watching the assigned videos indicated that ~75% of them watched them on time (Figure 1). A significant percentage of the participants indicated that they felt confident after watching the assigned videos (Figure 2).

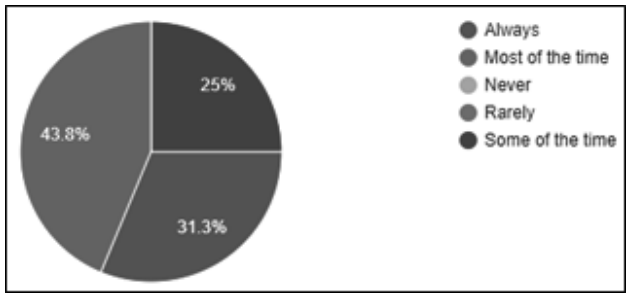

Figure 1 : Timeliness of the Participants in Watching Assigned Videos

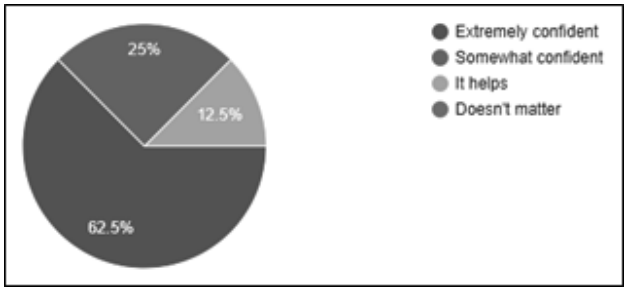

Figure 2 : Impact of Watching Videos on the Participants' Confidence

A critical aspect of flipped classroom survey was to assess the length of the video, which would be most suitable for a group of participants. It was anticipated that a majority of them would not be interested in watching videos of length more than 15-20 minutes but a almost half of them expressed an interest to watch videos of length ranging from 20 minutes to about 45 minutes (Figure 3). It was very comforting and motivating for the author/instructor to understand realize that the attention span of the participants was not limited to a few minutes. It was also an indication that the videos archived and used for the purpose of offering the flipped style classroom may have been interesting as well.

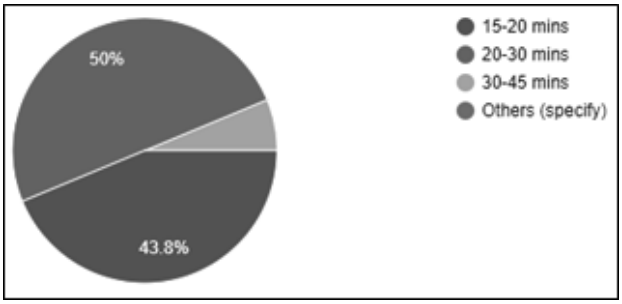

Figure 3 : Participants' Preferred Length of Videos

The next set of questions probed the motivation of the participants to watch the videos. The author in the role of an instructor wanted to ensure that the participants would watch the assigned videos in preparation for the class. Accordingly, at the beginning of the course, a percentage of the grade was assigned to watching the videos and commenting on them, indicating that the participants' had made an attempt to visit that site. An effort was made to trick the participants into thinking that their comments would indicate how much of the video was watched. It was not clear if this effort had an impact but it was certainly realized that a survey question was needed, which would allow the participants to indicate how much of the video were they actually watching. A good majority of them indicated that assigning a percentage of the grade would motivate them to watch the videos (Figure 4). It was realized post survey that the participants' opinion on the percentage of the grade assigned for watching the videos needed to be assessed.

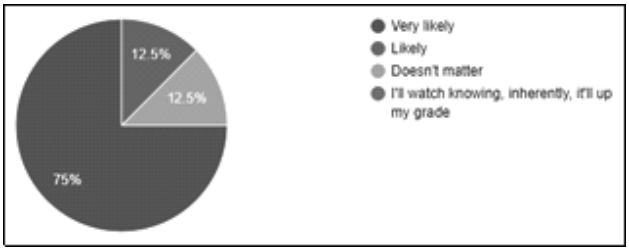

Figure 4 : Participants' Motivation for Watching Videos (Part 1)

A significant percentage of them also indicated that they would watch the videos if there was data, which showed that their grade would increase by a letter (Figure 5). The response to this question was very critical and has motivated the author to credibly show that watching videos and being prepared before coming to class is indeed beneficial. It was comforting to know that a good fraction of the participants realized that watching the videos ahead of time and being prepared before coming to class would inherently increase their grade (Figure 5).

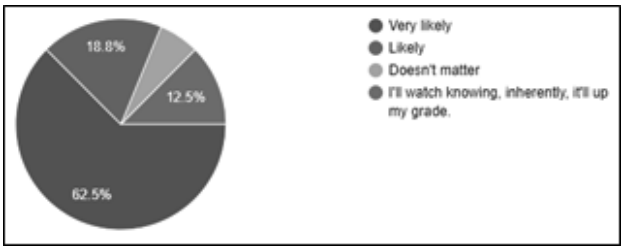

Figure 5 : Participants' Motivation for Watching Videos (Part 2)

The last set of questions probed the effort of the participants in such an offering. It was very motivating to know that a majority of the participants indicated that they would still come to class even if all the videos were made available for online viewing (Figure 6). It was clear through the responses to this query that students absolutely preferred coming into a class setting. Although, there may be data to show it, the author is of the opinion that HBCU students feel very strongly about attending in class lectures and it is particularly the case for his institution and program. The author, often in the class setting, teaches the importance of trust between students and their instructors. As part of this trust, the author emphasizes the two core components of trust as captured by John C. Maxwell [6, 7] – (i) competence and (ii) character. The last two questions of this set probed the students' character in terms of their at-home and in-class effort. An overwhelming percentage of the participants indicated that they would try hard at home if such an offering was made regular. Amazingly, all of them expressed their willingness to try hard in class if the flipped style classroom was to become a routine/norm.

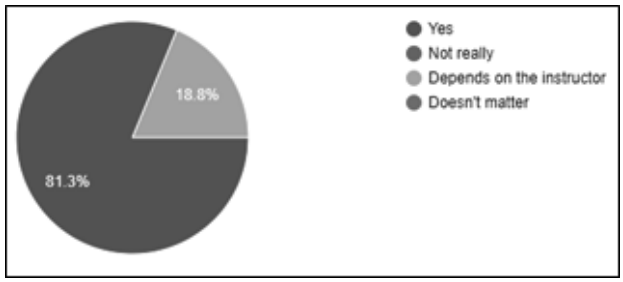

Figure : Participants' Motivation for Attend Class In Spite of Online Videos

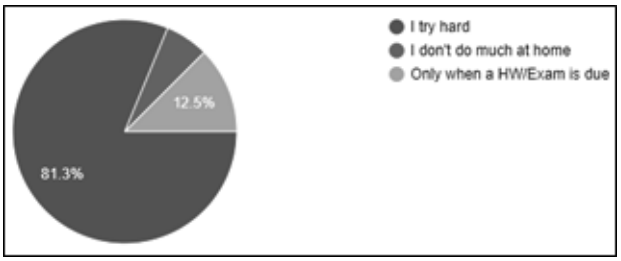

Figure 7 : Participants' Level of Effort At-Home

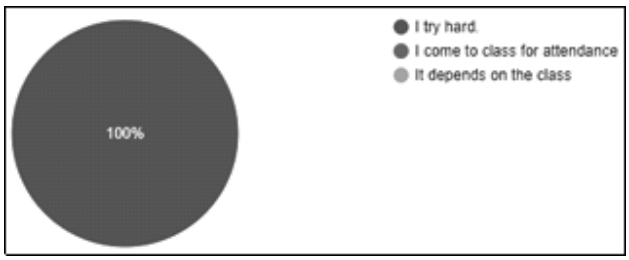

Figure 8 : Participants' Level of Effort In-Class

5. Conclusion and On Going Efforts

The author is making steady efforts to introduce a flipped style course offering based on archival videos for several years now. As part of this effort, observations show that such offerings may significantly benefit individuals struggling to digest the material in a single classroom setting. It has also been observed that several students have diligently watched all assigned videos and even with limited attention in class, have been able to ace the course. When probed on the most helpful aspect of watching the assigned videos, the following were identified as the key benefits:

- Convenience of rewinding aspects/contents, which were difficult to grasp during the first viewing of the videos
- Convenience of watching the videos at one's preferred time and pace
- The ability to pause and visualize concepts
- The benefit of additional information in the videos
- Referring to sections of the videos when completing assignments
- The potential of the recorded videos to assist in preparing for exams
- The realization that one may have missed a significant part of the lecture and the need to be more attentive in the classroom

The participants were also probed on the most non-helpful aspect of watching videos and being prepared ahead of a classroom and the following were the key highlights:

- Inability to ask questions at the time
- Sometimes, the length of the video may be too long or too short
- Sometimes, the content in the video may be redundant

It was abundantly clear from probing that the inability to ask question, clarify things and the absence of an instructor was a major limitation. The participants expressed a sense of anxiety that they would have to wait until the next class to seek get things clarified.

Although, the survey results have been truly enlightening, the author has also realized that there is a need to probe other parameters. There is ongoing effort to assess actual performance as a result of watching videos ahead of time and being prepared for class. The author is working towards assimilating data from YouTube analytics as well.

References

[1] Landivar, L. C., "Disparities in STEM employment by sex, race, and Hispanic origin," Education Review, Vol. 29, No. 6, 2013, pp. 911–922.

[2] Palmer, R. T., Davis, R. J., and Thompson, T., "Theory meets practice: HBCU initiatives that promote academic success among African Americans in STEM," Journal of college student development, Vol. 51, No. 4, 2010, pp. 440–443.

[3] Perna, L., Lundy-Wagner, V., Drezner, N. D., Gasman, M., Yoon, S., Bose, E., and Gary, S., "The contribution of HBCUs to the preparation of African American women for STEM careers: A case study," Research in Higher Education, Vol. 50, No. 1, 2009, pp. 1–23.

[4] "Historically Black Colleges and Universities Ranking," http://colleges.usnews.rankingsandreviews.com/best-colleges/rankings/hbcu.

[5] "Criteria for Accrediting Engineering Programs, 2018 – 2019 | ABET," https://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-engineering-programs-2018-2019/#GC3

[6] Maxwell, John C., "The 21 irrefutable laws of leadership: Follow them and people will follow you," HarperCollins Leadership, 2007.

[7] Maxwell, John C., "The 5 levels of leadership: Proven steps to maximize your potential," Center Street, 2011