Work in Progress: Development of Optional Summer Video Content for Preparation for Sophomore Year, with Initial Findings

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This work in progress paper will describe a new program that was implemented in the summer of 2016 to aid students who have completed their first year of engineering and are transitioning into their introductory, discipline-specific sophomore classes. At University of Notre Dame, all students complete a common first-year engineering program before entering their choice of engineering departments in the fall semester of their sophomore year. In all engineering departments, students are expected to have common college-level proficiency, knowledge, and skills in chemistry, physics, math, and have completed the first-year engineering classes. However, many students struggle with some of these concepts, making their transition into sophomore year much more difficult. In order to help better prepare these students, faculty members at Notre Dame developed a set of videos covering topics that students may need additional guidance and practice. These videos were released to students before the start of the fall semester and were completely voluntary. This paper will review initial findings from that release and detail some future directions for expanding this project as a first-year to sophomore bridge.

In starting this video site, faculty members from a number of first-semester sophomore courses. were asked to provide guidance on what pre-requisite concepts students would need to be successful in their classes. In each case, the instructors have an expectation that students have had an appropriate background for certain basic concepts and dedicate minimal, if any, classroom time to them. A sample of responses are:

(1) All Disciplines: Setting up and solving systems of linear equations through various techniques, including using MATLAB shortcuts or matrix manipulations such as Gaussian elimination or use of Cramer's rule.
(2) Disciplines with additional computer resource needs: Familiarization with university computer resources, specifically logging into and using Linux based machines
(3) Statics/Mechanics Course: Proficiency in calculating and manipulating 3 dimensional vectors
(4) Introduction to Electrical Engineering Course: Understanding of some basic physical laws such as Kirchhoff laws and application of mathematical tools (including first-order linear differential equations) to perform circuit analysis.

The video site was released to students 2 weeks before classes started and material has remained available to them throughout the fall semester. In this preliminary study, we focused on whether or not students would visit the site when available. A total of 504 site users were given access to the videos as determined by student enrollment in the sophomore engineering courses. As of the end of January 2017, a total of 402 students have visited the site (79.8% of all possible student users) with a total of 1821 visits. Student usage in this first implementation encourages the expansion and continuation of the project. Future work on this project will include:

(1) Expanding the video offerings to meet the needs of more students and additional courses that are not yet covered

(2) Collecting data on which resources were viewed most and at what point they were used
(3) Creating practice problems to enhance skill development in key areas
(4) Surveying and interviewing students and faculty to better understand impacts of the video on sophomore course readiness and performance.

Introduction

Over the past decade, many universities have invested significantly in first-year programming as a means of recruitment and retention. Many studies cite the first-year with low retention rates, making these large programming efforts an important first step in securing engineering graduates [1,2]. However, as the first-year closes and students turn to their sophomore year, many experience new challenges in their education. For students that struggled in the first-year, the advanced rigor of the sophomore year can be daunting. Others who were academically successful may be facing their first academic challenge in college as they enter the rigorous technical classes of sophomore year in engineering. Both these student populations are at risk of entering a "sophomore slump" which may lead to questioning their engineering major selection [3-5]. To combat this process, many universities are investing in how to better prepare students for their technical courses in the sophomore year.

One method to combat the academic challenges could be by retooling the content of first-year engineering courses. However, best practices for first-year engineering courses include a focus on design thinking, exploring engineering disciplines, and project based learning in multi-disciplinary courses [6-9]. Therefore, these courses are ideally suited to prepare students in skills and techniques that are common to all engineers, but often unable to provide content for each specific discipline. Making significant changes to this model could result in unintended consequences on first-year retention and is not an ideal solution. Another common option is to extend summer bridge programs beyond preparation for the first year. At many universities, at-risk students are identified before entering their first year and are asked to participate in a summer course before starting classes in the fall [10-13]. The programs provide academic success strategies, encourage math and science competence, and create a cohort of learners [10]. At several universities, these programs start in the summer before the first year and continue to include the summer between the first and second years and sometimes even during the sophomore year [12]. Many of these programs have shown good success, but these programs are expensive and necessitate small class sizes, leaving many students without these same resources.

This paper will focus on a work-in-progress at Notre Dame which seeks to address the academic preparation of students entering the sophomore year for all students in the College of Engineering. An optional summer video site was created that would extend some of the practices of the first year course throughout the summer. Thus, setting up the summer as an ideal preparation time for students where discipline-specific content can now be delivered. In this program, the first year class can continue to serve students using best practices for common first year experience courses, but students who are either not confident or lack competence in discipline-specific skills have a chance to address this before being academically responsible. In this paper, we describe the major research questions for this project, the video project design, our implementation plan, and briefly describe the expected assessments.

Research Questions

In the 2015-2016 academic year, engineering faculty at the University identified a need to help students prepare for their first engineering courses as sophomores. The ideal solution would provide course preparation by reinforcing background information and introduce topics to be covered in the first few weeks of the fall semester. In addition, the preparation was intended to be voluntary and accessible to any student who chose to participate. The material is offered at no additional cost to the students. Students also do not receive academic credit. With this in mind, we identified the summer as an ideal preparation time for students, much like the summer bridge programs that exist at many universities. To make the program easily accessible during the summer without requiring students to remain on campus, all materials were provided via the university learning management system (LMS), Sakai. At full implementation, this study will investigate the following research questions:

(1) Will students explore and use optional summer content if it is provided by the university?
(2) What are the appropriate topics for summer study? Do faculty and students agree on this content?
(3) How do students use the platform – when is it accessed and what materials are most popular? What courses and topics do students spend the most time on?
(4) What type of content best influences students' perceived competence and confidence in sophomore courses? Did sophomore students find value in the video program?
(5) Are there observable differences in student performance as a result of using the video platform?
(6) Could these videos be used as a facilitator to help students develop cohorts in their choice discipline before they begin their sophomore year, thereby improving their performance in subsequent years?

For this work-in-progress paper, the focus was almost entirely on answering the first question – if the platform is created, would students access the material? In addition, this paper focuses on the faculty's perception of appropriate topics for sophomore students which was used to create the initial video content for the summer 2016 launch.

Background Information

The University of Notre Dame is a suburban, private, research university in the Midwest serving ~8,000 undergraduate students. Most students at the university are traditional college age (18-22 years old), full time students, and live on campus during the academic year. The College of Engineering consists of approximately 1,200 students (sophomore through senior year) at the university. Approximately 500 students are enrolled in the First-Year of Studies, intending to enter the College of Engineering at the start of their sophomore year. Those students that intend to pursue an engineering degree have a common first year engineering experience. They take a number of classes that include calculus, chemistry, physics, and a two semester introduction to engineering course sequence. At the end of the first year, students officially declare a major and matriculate into the College of Engineering as sophomore students in the following Fall semester.

In the Fall of their sophomore year, students take their first department-specific courses. The majors are listed in Table 1, along with the sophomore engineering courses that are required for those departments. In addition to these courses, all engineering students are expected to be enrolled in (or have completed) General Physics II and Calculus III.

TABLE 1. REQUIRED SOPHOMORE ENGINEERING COURSES FOR ENGINEERING MAJORS

Department	Courses
Aerospace Engineering	• Statics • Introduction to Engineering Computing • Introduction to Aeronautics
Chemical Engineering	• Introduction to Chemical Engineering • Organic Chemistry I
Civil and Environmental Engineering	• Planet Earth • Introduction to CAD • Statics • Engineering Programming
Computer Science and Engineering	• Fundamentals of Computing • Discrete Mathematics
Electrical Engineering	• Introduction to Electrical Engineering • Introduction to Electric Circuit Analysis • Introduction to Computing
Environmental Engineering	• Planet Earth • Statics • Introduction to Environmental Engineering
Mechanical Engineering	• Statics • Introduction to Engineering Computing • Science of Engineering Materials

These courses provided the initial consideration for the content that would be included in the video course. During first implementation, we considered only courses offered by the College of Engineering and largely did not address any needs for Calculus, Physics II, or Organic Chemistry classes which are taught in the College of Science.

Video Course Description and Implementation

As described previously, creation and implementation of the summer sophomore preparation site is currently a work-in-progress. However, the goals for the course content at maturity are to provide:

(1) video content for the majority of classes identified in Table 1,
(2) practice problems to reinforce key concepts through self-testing for each course, and
(3) feedback and help using an online forum system.

In Year 1, the implementation focused on creating video content for courses that were determined to have the greatest need based on faculty feedback. Developers approached the

faculty that teach each of the sophomore level classes for input on the most necessary skills for early success in their courses. They were asked to identify background proficiencies that students needed and/or content taught in the first few weeks of the semester. With this input, the following modules were created which were based on what we determined to be the most needed and easily accessible through the current video structure.

- For All Engineering Disciplines
    - Solving Systems of Equations (3 videos)
    - Enhanced Programming Practice (7 videos)
- Aerospace and Mechanical Engineering
    - Statics Preview – 3D Vectors (3 videos)
    - Using Linux Computers/Campus Computing Resources (4 videos)
    - Introducing Fortran Programming (3 videos)
- Chemical Engineering
    - Introduction to balance equations (2 videos)
- Civil and Environmental Engineering
    - Statics Preview – 3D Vectors
- Computer Science and Computer Engineering
    - Using Linux Computers/Campus Computing Resources
- Electrical Engineering Students
    - Using Linux Computers/Campus Computing Resources
    - Kirchoff Laws and Introduction to Electric Circuit Analysis (4 videos)

These modules were selected in part to ensure that all students could enter their sophomore courses with a more equitable chance to succeed. For instance, nearly every department noted that students would be required to solve systems of equations under various applications. However, students may take linear algebra in their first year or second year based on their earned math Advanced Placement credit. A considerable number of students did not have the skills needed to solve systems of equations using matrix math while others had already completed a college course on the topic. The video course provided an introduction to the most necessary proficiencies for solving systems of equations in an effort to create a more equivalent skill set for all students.

Implementation

All content was prepared in May – July 2016 for release in August 2016. The course was created in Sakai, an LMS that was regularly used by students throughout their first-year and accessible from any device with an internet connection. Instead of asking students to opt in to the course, all students enrolled in one of the sophomore level courses were auto-enrolled into the summer preparatory course on August 11, 2016. A total of 504 site users were enrolled in the course.

There was no publicity of the new course offerings until the date of release. Approximately two weeks before the start of the academic year, an email was sent to the enrolled students to notify them of the new resource and encourage them to visit the site. Use of this site was entirely

voluntary and no additional notifications were provided to the students. The course remains open to the students throughout the academic year, allowing them to review any material they feel would be of use. While instructors of the sophomore courses were notified of the course offering, we do not believe any instructors referenced this material in their courses.

Initial Findings

In this study, we assessed only to what degree students visited the site in an attempt to answer the first research question – will students explore or use optional content if it is provided?

All assessment data was generated by the LMS site analytics software. At the time of this writing, 402 members have visited the site at least once, representing 79.8% of the possible users. Figure 1 represents the number of unique visitors and the total number of site visits for all students since the site was published in August.

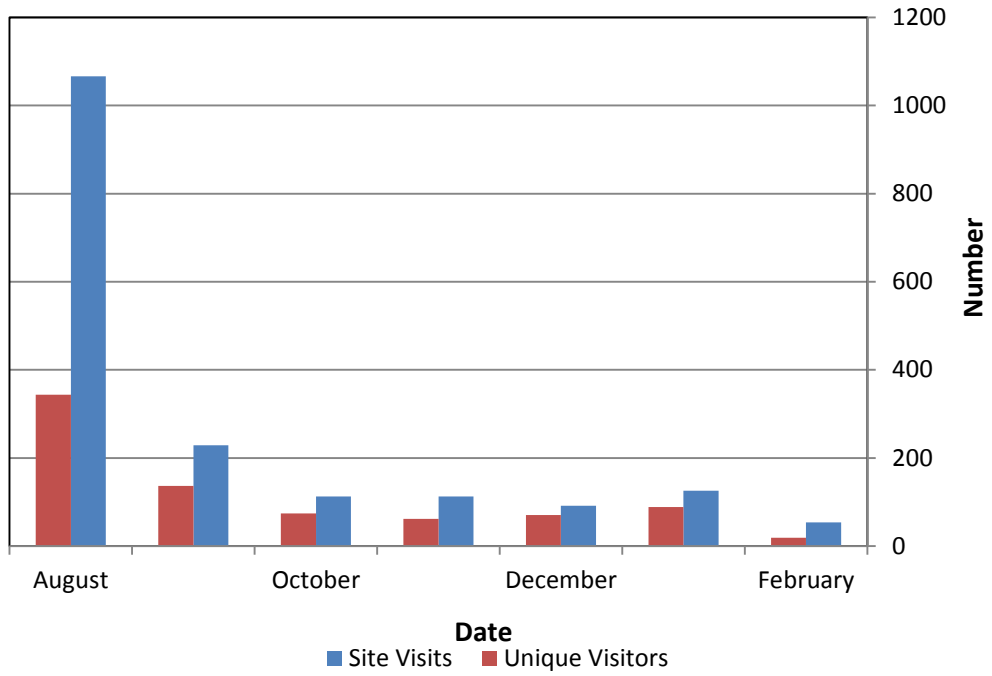

Figure 1: Total student visitors and their site visits to the video course over the first six months of implementation.

As shown in the figure, the largest number of site visits occurred in August with the number declining until October. From October until the time of writing, the number of site visits and unique visitors has remained fairly stable. This matches closely with our expected behavior. Because content is background or introductory in nature, most of the sophomore classes will move beyond these topics sometime in September. Figure 2 gives a more detailed view of site use in the first month of implementation when we expected the most use.

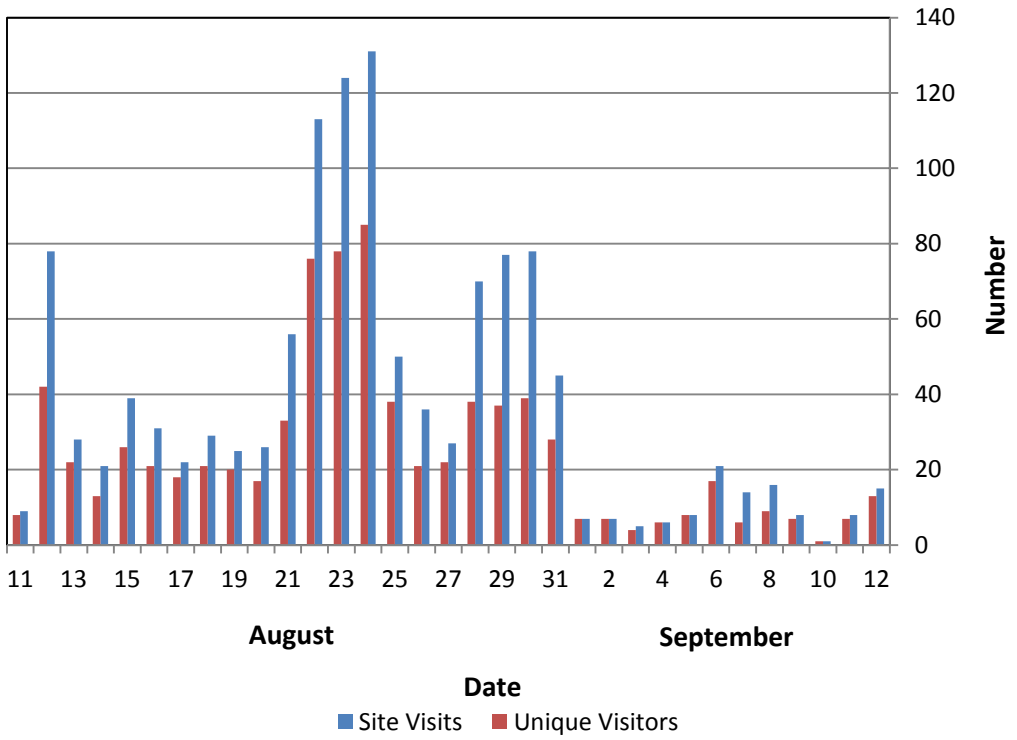

Figure 2: Daily visitor use for the video course for the first month of implementation.

From Figure 2, the site visits peaked during the week of August 21st – the first week of classes at the university. This again matches anticipated usage. Once courses move past initial topics and begin providing their own homework and assignments, student use of this optional material decreases. Additionally, 10.8% of students visited the site at least 10 times from the site publication as of the end of January 2017. Due to the setup for the course site, developers were unable to determine which modules of the course were most visited or which videos were watched during these visits. However, the first research question has largely been answered. If voluntary materials are created, students will at least visit the site with a number of students appearing to use the site for part of their sophomore development. The next stage of implementation anticipates tracking additional use analytics, such as which videos are watched, how long they were watched, and how many times they were watched. We are also considering monitoring student usage with the objective being to encourage low use students to visit the site.

Conclusions and Future Implementation

In conclusion, the initial implementation of the video site was deemed a success and worth pursuing more aggressively. Students were willing to visit the site with many students visiting multiple times. Because of this initial response, the university is committed to continuing the project and providing additional resources. Implementation in year 2 will include:

(1) Creating additional course content, including calculus skills,
(2) Expand the videos in current video modules,
(3) Providing practice problems and solutions for self-testing, and

(4) Employing several student workers to monitor student questions and provide feedback through an online forum system.

Due to the additional materials available to students, the launch date for the summer 2017 course is targeted for June 2017. By moving the date up, students will have more time to access all content that is pertinent to their major choice.

In addition to the added content for students, we are developing a more rigorous assessment plan. This will include extensive data from the LMS as well as student survey and interview feedback. We expect that the video course will continue to phase in implementation over the next few years with guidance from student and faculty feedback.

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