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Help Me Help You: Educational Value, Perceived Usefulness, and Creativity of Student-generated Course Review Material

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Abstract

Supplemental instructional material provides a variety of content delivery, outside of regular class meetings, to meet student learning style preferences. Many of these tools are engaging and interactive, but most of them have one thing in common: they were created for students by teachers. Meanwhile, of their own accord, students create study aids in preparation for major graded events. These tools vary in style, method, complexity, and completeness. This paper examines possible educational benefits of leveraging such student-generated course review material as a supplement to traditional, teacher generated review materials across various incoming student GPA's and learning styles.

In the first two mechanics courses taken by engineering students at the United States Military Academy (USMA), at West Point, NY, students were given an assignment near the end of the semester to create a study aid. This assignment was designed to combine creativity with students understanding of technical content and require students to clearly communicate course content. Only general guidance was provided in order to reduce unnecessary constraints and encourage creativity. Study aids were created by groups of 2 or 3 students on a specific topic from the course. The types of student-generated products included: short instructional videos, solutions to example problems, topic outlines, and written summaries of course material. Once vetted by the instructors, these student generated tools were posted to the course web page and made available to the rest of the students to use during final exam preparation.

Student access to each type of study aid via the course web page was measured and compared to assess students' perceived value of one type of study aid over another. Using current course grades, likelihood to use specific study aids based on previous performance in the course was also assessed. As part of the assignment each student completed learning styles and creativity surveys. Results from the learning styles and creativity surveys were used to assess which types of study aids were made by students with particular learning style preferences or creative tendencies.

Introduction

It is well established that people learn in different ways.[1] Realizing this, effective instructors provide course content using a variety of methods to appeal to different learning styles and assist students in developing their ability to learn in styles other than their preferred.[2-4] In-class and out-of-class content delivery methods often include: lecture, small-group discussion, problem-solving sessions, demonstrations, hands-on experiences such as laboratory experiments, textbook readings, slide shows, movie clips, computer simulations or short instructional videos.[5] Each option is created or chosen by the instructor and used by the students. Perhaps a student's preferred content delivery method was not provided, rendering it unavailable unless they create it themselves as a study aid during the course.

Many students create study aids while reviewing course material and in preparation for exams. These may include crib sheets, outlines reviewing key concepts, mind maps, or summary paragraphs. For mathematics and engineering courses, students often prepare for exams by reworking homework problems or working review problems provided by instructors or found in old course files. The act of creating study aids or working problems can improve understanding of course material and the student's ability to recall that information but it does not require the student to communicate this knowledge with others nor does it require or encourage creativity.

Effective communication skills are critical for engineers and have long been a student outcome required by ABET.[6] In recent publications describing desired characteristics of future engineers, creativity has also been a common thread.[7,8] The literature includes a variety of examples of methods that can be used to focus on one or both of these areas.[9-12] The assignment described in this paper was developed to encourage creativity and require clear communication of engineering mechanics concepts by students, for students.

This paper describes an assignment requiring students to create review material for fellow students within two mechanics courses during its initial implementation during the Fall 2015 semester. The two courses were: Fundamentals of Engineering Mechanics and Design (MC300, which covers statics and basic mechanics of materials), and Mechanics of Materials (MC364, which covers traditional mechanics topics and introduces material science). The end-of-semester assignment asked students, working in small groups, to create a product which summarized, reviewed, or otherwise covered content from one of the major topics within the course. Guidance was limited in order to encourage creativity and reduce unintended constraints. The only stipulation was that the product must be able to be distributed through the course website. Assessment within this study focused on two aspects: (1) learning style preferences and creative aptitude of the students generating the content, and (2) usage preferences for students accessing the content developed by others.

Background

Modern society is driven by change and innovation. Challenges such as climate change, globalization, changing demographics, and global security require innovative technological solutions. One goal of engineering educators is to prepare their students to develop the next wave of innovative technological solutions.

Engineering solutions can be developed via either creative or routine problem solving techniques. Routine problem solving involves solving old problems with old solutions (replication) or new problems with old solutions (stagnation).[12] Routine problem solving techniques can provide solutions to current societal problems, but typically do not lead to significant progress or technological innovation. The goal of engineering educators is to inspire students to innovate technology and key to developing this type of student is to build a strong basis in the core engineering disciplines while providing student opportunities to exercise creative thinking.

The balance between including creative opportunities and technical content within an engineering education is difficult to establish and perhaps even more difficult to achieve. Adding to this dilemma is the “safety based” culture that leaves little room for defects in new designs. Society expects engineers to plan for all contingencies and calculate the performance of any design with an associated factor of safety. This expectation leads many engineering curricula to concentrate on depth over breadth.[12] While problem based learning and other similar techniques are excellent at passing on theory, they do little to promote creativity and may result in graduates with limited creativity. In response to this and the recognized value of creative problem solving techniques required for innovation, many engineering educators have begun developing practical methods to incorporate assignments that encourage creativity into the curriculum and individual classes while still emphasizing engineering fundamentals.

Traditionally, engineering courses are structured in a deductive manner which begins with instruction on theories and progresses towards application of those theories. Liberal arts courses, on the other hand, often rely on an inductive approach in which specific topics are introduced through case studies, observations, or problems. The underlying theories are then taught after the student has established a need for the subsequent theory.[13] Use of an inductive approach may provide opportunities to introduce more creative thinking into engineering courses. Examples of inductive teaching methods with growing popularity include: inquiry learning, problem based learning, project based learning, and discovery learning. [13] One of the most common inductive techniques employed by engineering instructors is project based learning.

Project based learning is an inductive technique that is widely used in engineering courses with projects such as lab experiments. There are three types of projects based on the degree of autonomy which as student is allowed: Task Project, in which the scope and methodology are prescribed by the professor; Discipline Project, in which the instructor defines the subject and terms, but students identify the specific project; and Problem Project, in which students have complete autonomy. [13] Opportunities to exercise creativity increase as the degree of autonomy provided to the student increases, but increased autonomy risks students missing important points and not constructing the appropriate engineering knowledge base. [13] The authors of this paper considered the discipline project approach to allow engineering students a method to exercise creativity with classroom study/ preparatory materials.

Bloom’s Taxonomy provides a framework within which to create learning experiences which develop students’ critical and creative thinking skills. Critical thinking is defined as “The disciplined mental activity of evaluating arguments or propositions and making judgments that can guide the development of beliefs and taking action,” while “Creative thinking requires an individual to look at parts and relationships (analysis) and then to put these together in a new and novel way.”[14] To achieve the higher order thinking skills required of a creative thinker, the engineering educator must provide opportunities for students to work at the analysis/ synthesis level of Bloom’s taxonomy, but current course materials often fail to reach these higher order skills.[15]

Use of student generated content is a potential means to reach these higher levels on Bloom’s taxonomy. There are a variety of examples of student generated content available in the literature. For example, Kimball required history students to record podcasts which summarized required readings within a strict time limit.[16] These podcasts, after being corrected of any errors identified by the instructor, were uploaded to the course website and made available to all enrolled students. Feedback from the students was generally positive: the podcasts were useful in understanding course material and preparing for exams. Another common example of student generated content is creating questions for use in review or actual exams. Bates et al reported results from the use of PeerWise to do this in an introductory physics course and found that students reported developing better understanding of course material by crafting questions but limited value of answering other student's questions.[17] Another popular method for increasing student interaction and development of knowledge is through collaborative websites with content added, deleted, or edited by students, often called wikis. These collaborative tools can aid in developing effective communication skills and critical thinking. Roussinos and Jimoyiannis described a project-based wiki assignments in a communication technologies course. The instructors required creation of a wiki on a communication technologies topic but the student groups were free to choose the specific topic, thus it was a "Discipline Project". In this case, the learning value varied widely among the groups with some operating at higher cognitive levels and demonstrating improved critical thinking and collaboration skills and other groups meeting minimal requirements.[18]

Requiring students to develop their own student generated content and posting this content for review on the course website has the opportunity to inspire higher order thinking skills and develop communication skills. With the right emphasis and encouragement, creativity in the manner in which the material is delivered can be displayed. To ensure an appropriate level of academic rigor and accuracy, the student-generated content should be reviewed by instructors for prior to making it available to other students. This combination of student generated materials with instructor oversight will foster student's creative thinking skills while ensuring the core engineering theory is correct and complete.

Methods

Implementation of this project was accomplished in three phases. The first phase included content generation and submission, the second included publication of content for student access, and the third included analysis of the data gathered during the previous two phases. Both courses followed the same general procedures, with one major exception. The assignment in MC300 was offered as an optional bonus opportunity for all 200 enrolled students, while the assignment in MC364 was mandatory for two of the seven sections (30 of 107 enrolled students). In both courses, all enrolled students had access to the review products whether or not they created one. The following contains a detailed description of each phase.

Phase I - Content Generation and Submission

This phase began with dissemination of the assignment requirements by the instructors to the students. In both cases this occurred approximately three-quarters of the way through the course. The assignments were distributed in a manner similar to that for a standard problem set (posted to the course webpage in MC300, hard copies handed out in class in MC364). Appendix A and B contain the assignment sheets for MC300 and MC364, respectively. To complete the assignment, students self-selected into groups of two or three individuals and chose a topic from a list of instructor-determined course content areas. In MC300 no limit was put on the amount of products that could be submitted in each content area nor was there a requirement that all topics be covered by a student group. In MC364, however, submissions were limited to two per content area (with the exception of one area that required three submissions due to the number of groups). This was done on a first-come, first-served basis, and ensured review products would be created for all topic areas. By design, little guidance was given on the scope or format of the review products and submissions were required to be in a form suitable for posting to the course website. It was made clear to students that their products would be made available online to their peers. As part of the assignment, each student was required to submit results of an online learning style inventory[19] and an online creativity survey.[21] These surveys are described in more detail in the Phase III discussion below. This phase concluded with electronic submission of the review products, the learning style inventories, and the creativity surveys.

Phase II - Publication

This phase began with instructor review of each submission to verify accuracy of content and appropriateness for dissemination. Approved submissions were posted without modification to the course web page and made available to all students enrolled in the course. Files were grouped in folders according to topic area and a brief description of each product was included with each file. The webpage was set up in a manner that allowed by-name tracking of download history visible only to instructors. The products were left available through the end of the final exam period. This phase concluded with completion of the respective course final exams and subsequent submission of course grades.

Phase III - Analysis

This phase took place after completion of the course, once final course grades were available. Data from the learning style inventories, creativity surveys, product assessment, download history, and pre- and post-final exam grades was reduced and analyzed to identify trends.

Learning Style Inventory

Figure 1 depicts the output from a representative student learning style inventory submission. This output was generated by the website which hosts the survey.[19] On the figure's left ACT, SEN, VIS, and SEQ represent active, sensing, visual, and sequential learning styles, respectively. On its right REF, INT, VRB, and GLO represent reflective, intuitive, verbal, and global learning styles. Based on their submission, each student was assigned single number representing each row of the figure. Numbers on the left side of the figure were assigned negative values. As an example, the student submitting Figure 1 was assigned the set of values [5, -1, -9 -1] indicating that he or she was demonstrated a moderate preference for reflective learning, slight preference for sensing and sequential learning and a strong preference for visual learning. Such analysis was conducted for each individual student who participated in a group that submitted a review product and their numerical scores recorded in a database of all participating students.

As Felder and Silverman explain, an active learner prefers engaging with information through physical activity or discussion while a reflective learner prefers introspection. A sensing student prefers to perceive information as sights, sounds, and physical sensations; an intuitive learner prefers possibilities, insights, and hunches. Those visual learners most effectively perceive information through pictures, diagrams, graphs, and demonstrations while sounds and words are preferred by verbal (or auditory) learners. The final category describes how the student progresses toward understanding: sequential learners prefer continual steps and global learners like making large jumps and learning holistically.[1]

```
ACT                                         X                   REF
      11   9   7   5   3   1   1   3   5   7   9   11
                             <-- -->

SEN                          X                                  INT
      11   9   7   5   3   1   1   3   5   7   9   11
                             <-- -->

VIS        X                                                    VRB
      11   9   7   5   3   1   1   3   5   7   9   11
                             <-- -->

SEQ                          X                                  GLO
      11   9   7   5   3   1   1   3   5   7   9   11
                             <-- -->
```

Figure 1 Representative Results from the Learning Styles Inventory

Creativity Survey

A typical student creativity survey submission is shown in Figure 2. This output was generated by the website which hosts the survey.[21] In addition to the creativity score assigned by the survey, in the case of this student, 61.42, each student was assigned a numerical value for abstraction, connection, perspective, curiosity, boldness, paradox, complexity, and persistence. These values were obtained by reading the intersection of the shaded area with the axis for each adjective and assuming the concentric circles increase in value with the inner circle representing one and the outermost circle representing five. Thus, the student who submitted the survey captured in Figure 2 would be assigned the values [2.3, 1.7, 2.1, 2.5, 2.0, 3.0, 2.7, 2.0].

The creativity survey website defines the eight categories as follows:

- Abstraction is "the ability to abstract concepts from ideas",
- Connection is "the ability to make connections between things that don't initially appear to have an apparent connection",
- Perspective is "the ability to shift ones perspective on a situation – in terms of space and time, and other people",
- Curiosity is "the desire to change or improve things that everyone else accepts as the norm",
- Boldness is "the confidence to push boundaries beyond accepted conventions" and "the ability to eliminate fear of what others think of you",
- Paradox is "the ability to simultaneously accept and work with statements that are contradictory",
- Complexity is "the ability to carry large quantities of information and be able to manipulate and manage the relationships between such information", and

- Persistence is “the ability to force oneself to keep trying to derive more and stronger solutions even when good ones have already been generated”.[21]

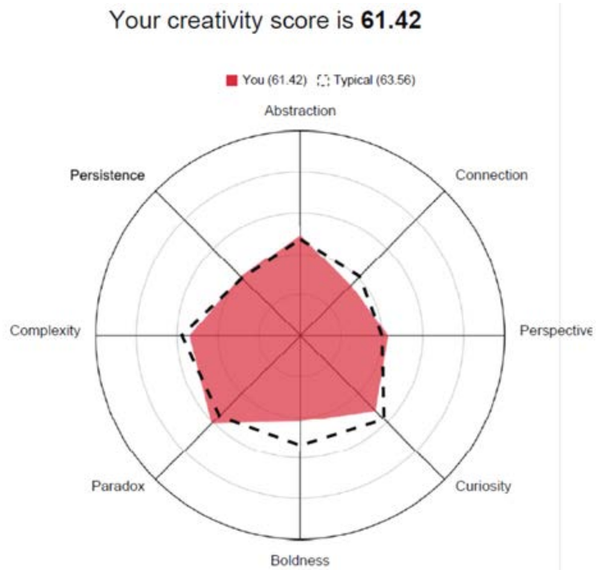


Figure 2 Representative Results from the Creativity Survey

Product Assessment

In addition to scoring the products and providing student feedback on their products, the format, content, and creativity of each submitted review product was assessed and recorded. Three general categories of products were produced: slide shows, summary sheets (hand-written or in a word processor), and videos. Products included one or more of the following content types: concepts and definitions, derivations of equations, explanation of equations (i.e. definition of variables within equations), worked example problems, and common student errors. The creativity of each product was judged by a single instructor to ensure consistency. Creativity of the format and content was assessed separately. Creativity of format refers to students organizing the material in a different manner than it was presented in class. For example, several students created slide shows that were in a game show format and others created scripted videos that were entertaining and informative. Creativity of content refers to students presenting the content in a unique way – example problems set in student life situations or within a movie or the inclusion of humor, for example.

Download History

Using the tracking capability of the course website the date and time that each student accessed each review product was recorded. This data was exported by the website in a database form suitable for further aggregation and analysis.

Student Grade History

From course files, the course grades for each student were recorded. The grade that each student had earned prior to the final exam (including all other course requirements) and the grade that each student earned on the final exam was included in a database. Statistical analysis of the following populations was conducted: the entire course, the students who generated review content, and the students who downloaded review products.

Results and Discussion

As discussed above, the assignment was provided as an extra credit opportunity to all students enrolled in MC300 and required in two of the seven sections of MC364. For this reason, the outcome of the assignment in each course will be described separately. As the work presented herein is part of an ongoing study, the potential influence of the type of assignment (required vs extra credit) is an important consideration and is discussed at the end of this section.

MC300: Fundamentals of Mechanics and Design

This assignment was made as an optional bonus opportunity to the 200 students enrolled in MC300. A total of 51 students submitted a review product. Students had freedom to choose what topic to cover from an instructor provided list. There were no limitations on the number of groups that could submit products for a given topic, nor a requirement that all topics be covered. As shown in Table 1, there were 34 products submitted from within the primary course topics. For a variety of reasons seven products were not published to the course website.

Table 1 Number of MC300 Review Products Submitted and Posted to Course Website

Topic	No. of Submissions	No. Posted to Course Website
2D Equilibrium	5	5
Truss Analysis	8	6
Hooke's Law	5	4
Material Properties	2	2
Axial Deformation	1	1
Buckling	3	2
Frame Analysis	1	1
Shear and Moment Diagrams	7	5
Beam Deflections	2	1
TOTAL	**34**	**27**

Table 2 provides details about each individual product produced by MC300 students. Most were prepared by groups of two students although some were prepared by an individual. The table also provides learning style preferences and creativity scores as reported by the students who created each review product. In several cases these results were not reported by the student. Ten products were in slide format, 20 were review sheets, and two were videos. Most products included discussion of the concepts and definitions and worked example problems. Only one product covered the derivation of equations and six discussed common student errors when working problems within the content area. The instructors judged nine products as creative in format (use of a scenario or mind map, for example) and seven products as creative in content (several included humor or set the example problems in movies such as Star Wars).

Table 2 Summary of Student-Generated Review Content (MC300)

		Format			Included					Creativity	
Topic	**LSI* (Creativity)**	**Slides**	**Summary Sheet**	**Video**	**Concepts / Def'ns**	**Derivations**	**Equations**	**Example Problem**	**Common Errors**	**Format**	**Content**
Equilibrium 1	no surveys no surveys	X			X		X	X			
Equilibrium 2	A/I/Vi/G (80.85) A/S/Ve/S (51.04)		X		X		X				
Equilibrium 3	no surveys no surveys	X						X		X	
Equilibrium 4	no surveys no surveys		X					X			
Equilibrium 5	R/I/Vi/S (71.73) no surveys		X		X		X	X			X
Axial Deformation	no surveys no surveys	X					X	X	X	X	
Beam Deflection	R/I/Vi/S (70.33) A/S/Vi/S (67.90)		X					X			
Beam Deflection NOT POSTED	R/S/Vi/S (57.94) no surveys	X						X	X		
Buckling 1	A/S/Vi/S (52.44) R/S/Vi/G (56.96)		X		X			X	X		
Buckling 2	A/S/Vi/G (66.92) A/S/Vi/G (46.95)		X		X		X				
Buckling NOT POSTED	no surveys		X					X			X
Frame Analysis	no surveys		X		X			X			X
Hooke's Law 1	A/S/Vi/S (42.20) no surveys		X		X		X			X	X
Hooke's Law 2	no surveys no surveys		X		X		X				
Hooke's Law 3	no surveys	X			X		X				X
Hooke's Law 4	R/I/Ve/G (82.94) R/I/Vi/S (60.93)	X			X		X	X	X		X
Hooke's Law NOT POSTED	A/I/Vi/S (53.90)		X		X		X				

*Learning Styles Inventory Results: [**A**ctive or **R**eflective] / [**S**ensing or **I**ntuitive] / [**Vi**sual or **Ve**rbal] / [**S**equential or **G**lobal]

Table 2 Continued

		Format			Included					Creativity	
Topic	**LSI* (Creativity)**	**Slides**	**Summary Sheet**	**Topic**	**Concepts / Def'ns**	**Derivations**	**Equations**	**Example Problem**	**Common Errors**	**Format**	**Content**
Material Properties 1	no surveys no surveys	X			X					X	X
Material Properties 2	R/S/Vi/S (57.03) S/I/Vi/S (61.00)		X		X					X	
Shear and Moment Diagrams 1	A/S/Vi/S (58.43)		X					X			
Shear and Moment Diagrams 2	R/I/Ve/G (48.19)		X			X	X	X	X		
Shear and Moment Diagrams 3	no surveys		X		X			X		X	
Shear and Moment Diagrams 4	A/S/Vi/G (52.58) A/S/Vi/S (63.16)			X	X		X	X		X	
Shear and Moment Diagrams 5	A/S/Vi/S (55.08)			X				X	X	X	
Shear and Moment Diagrams NOT POSTED	no surveys no surveys	X			X			X			
Shear and Moment Diagrams NOT POSTED	A/S/Vi/S (49.93)		X					X			
Truss Analysis 1	A/S/Vi/S (49.37)		X		X			X			
Truss Analysis 2	A/S/Vi/S (64.42)		X		X						
Truss Analysis 3	no surveys R/S/Vi/S (53.20)		X					X			
Truss Analysis 4	no surveys no surveys	X			X						
Truss Analysis 5	no surveys no surveys		X		X			X			
Truss Analysis 6	no surveys no surveys	X			X			X		X	
Truss Analysis NOT POSTED	No LSI (58.43) R/S/Vi/S (42.41)	X			X			X			
Truss Analysis NOT POSTED	R/S/Vi/S (57.24) A/S/Vi/S (55.01)		X		X			X			

*Learning Styles Inventory Results: [**A**ctive or **R**eflective] / [**S**ensing or **I**ntuitive] / [**Vi**sual or **Ve**rbal] / [**S**equential or **G**lobal]

Based on results from Felder's learning styles inventory,[19] the 45 students who completed the inventory were predominately active/sensing/visual/sequential learners (see Figure 3) which is similar to the "average" engineering student.[20] These student preferences suggested that the majority of the review products produced would likely match these learning styles. For example, most were expected to make use of pictures and diagrams and present the information in a linear manner. Few were expected to present material only as written summaries or from a holistic view, such as a mind map.

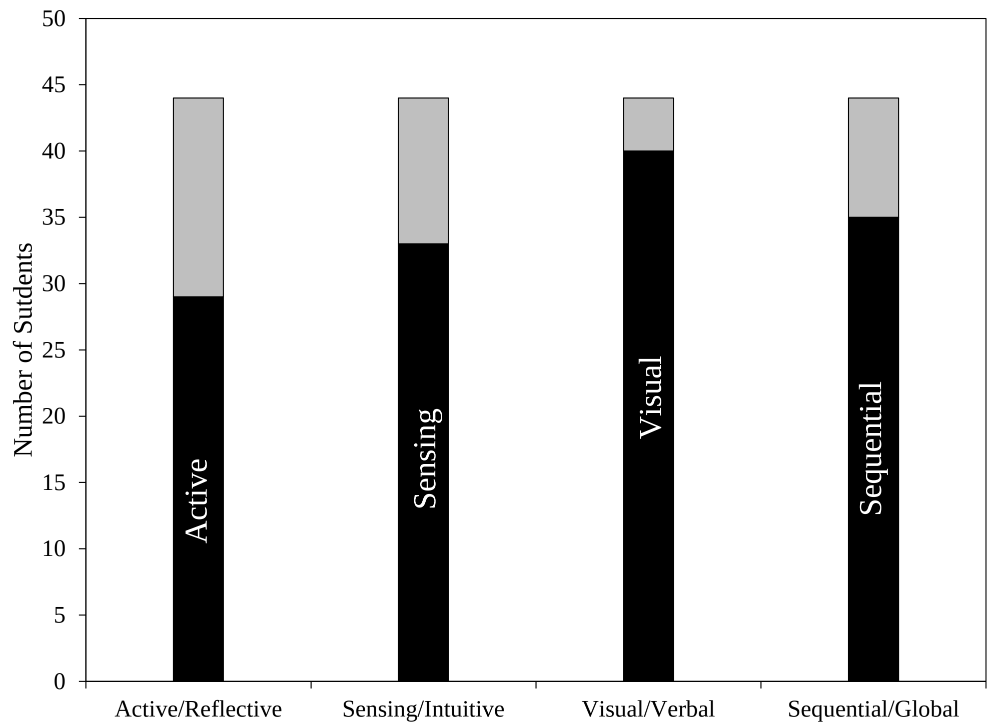


Figure 3 Distribution of Learning Styles (MC300)

The average creativity score from the TestMyCreativity survey[21] was 58.5 (the typical score is 63.6) with all areas being slightly lower than average. Average results from the creativity survey are shown as the solid red line in Figure 4 and the red dotted lines depict +/- 1 standard deviation from the average. Typical results, according to the website, are shown as the black dashed line. Given that students scored average for creativity, it was expected that most products would be similar to what was presented in class or available in other sources.

The course had a total of 200 students enrolled: 94 (47%) accessed the review products at least one time during the week of final exams. As Table 3 lists, the products focused on axial deformation and equilibrium were the most popular, with an average of over 40 students accessing each of the products produced in these areas. The remaining topics all had roughly 30 students who accessed at each product. In nearly all cases, if a student opened one review product within a topic area, they opened all available review products within that area. This suggests that, given the range of topics, students used the products created for the areas they were least comfortable when preparing for the final exam. Of the 51 students who generated content, 32 (63%) accessed content created by others suggesting that creating the review content increased the propensity to use student-generated content.

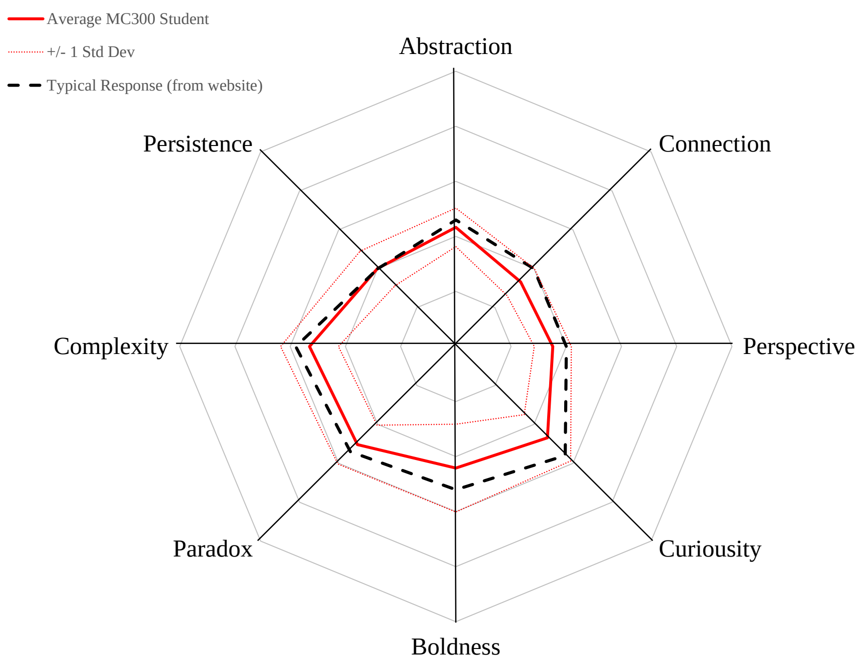


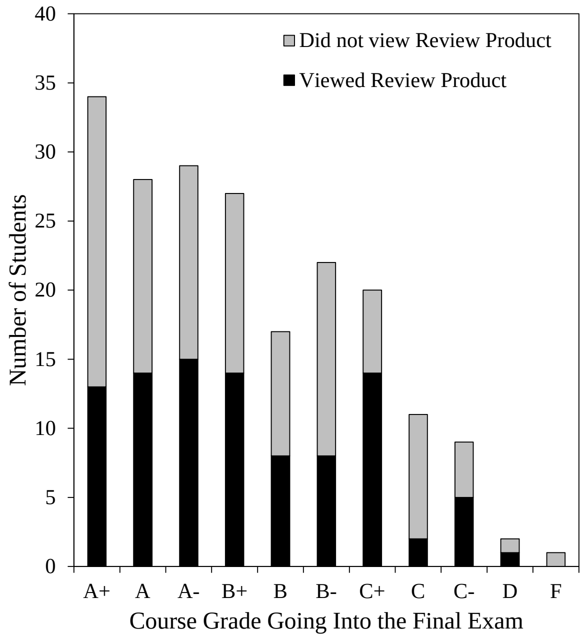
Figure 4 Average Creativity Score (MC300)

Table 3 Average Number of Students Who Opened Products within each MC300 Topic Area

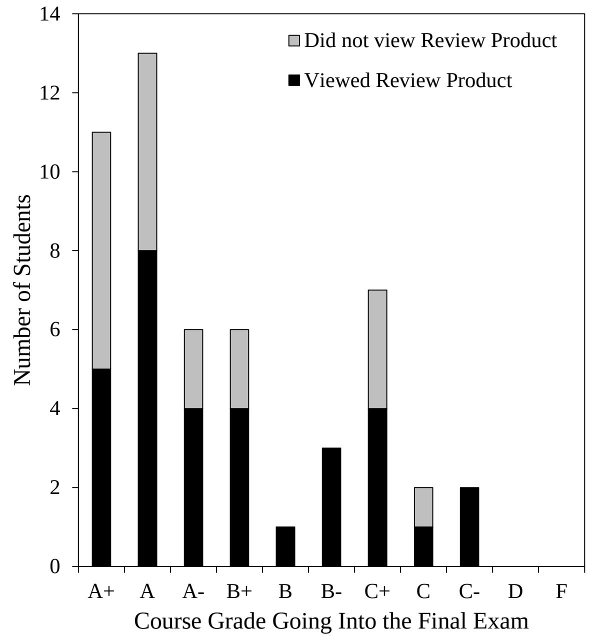
Topic Area	No. of Students
Equilibrium	41
Axial Deformation	44
Beam Deflection	33
Buckling	31
Frame Analysis	29
Hooke's Law	30
Material Properties	29
Shear and Moment Diagrams	33
Truss Analysis	30

Figure 5 shows usage preferences by the course grade the students had going into the final exam. While we expected to see students with lower grades use the resources at higher rates, they did not do: the student-generated review content was used nearly equally by students of all aptitudes.

Review products were made available to all students on 10 December 2015 in preparation for the final exams scheduled on 17 December (for 49 students), 18 December (for 136 students), and 19 December (for 15 students). As Figure 6 shows, students accessed the review material in largest numbers the day before and the day of the exam. The variation in popularity of topics is also evidenced in this figure.



(a)



(b)

Figure 5 Usage Based on Grade Going Into the Final Exam:
(a) Entire MC300 Course Population and (b) Students Who Generated Content

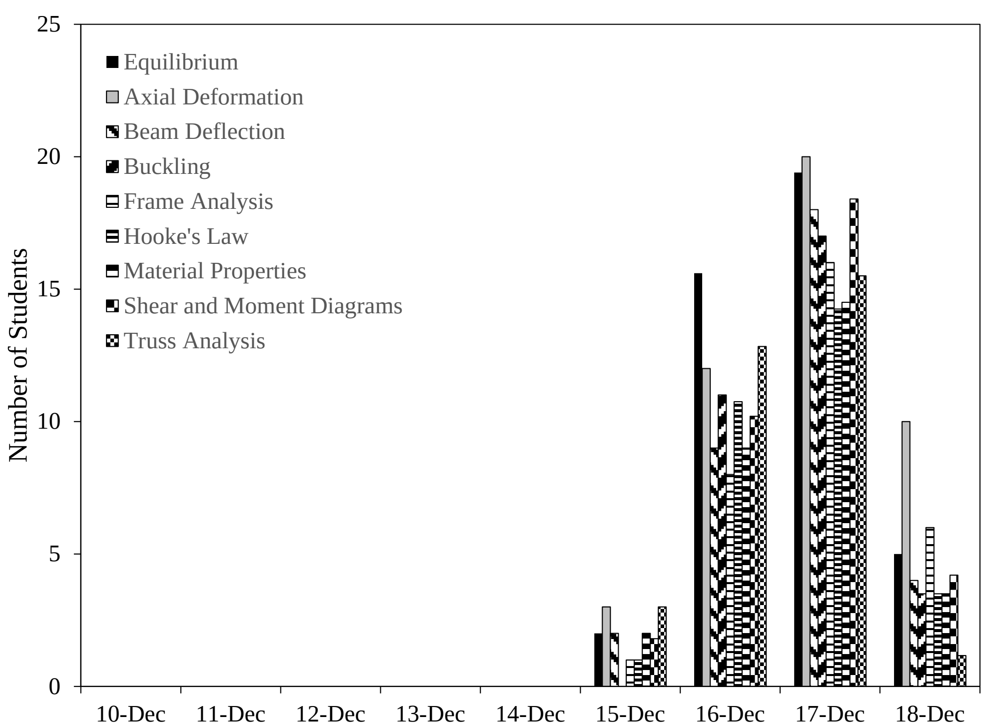


Figure 6 MC300 Review Products Usage by Date

MC364: Mechanics of Materials

This assignment was required by the instructor of two sections (30 total students) of MC364 and the products were made available to all students enrolled in the course. Students, in groups of two, could choose their preferred topic for an instructor provided list, but no more than two groups were permitted to choose a given topic so that every topic would have a review product created by students. As shown in Table 4, there were 15 total products created and 14 posted to the course website. The one product not posted had content that was inappropriate for including on the course website.

Table 5 provides details about each individual product produced by MC364 students. All were prepared by groups of two students. Provided in this table are learning style preferences and creativity scores as reported by the students. Eleven products were in slide format, two were review sheets, and two were videos. Most products included discussion of the concepts and definitions, review of applicable equations, and worked example problems. One product covered the derivation of equations and three discussed common student errors when working problems within the content area. The instructor judged four products as creative in format (a game show using slides or a scripted video, for example) and one product as creative in content (the scripted video was set in the 1950s and included humor). The creativity judgment is subjective to the individual instructor.

Table 4 Number of MC364 Review Products Submitted and Posted to Course Website

Topic	No. of Submissions	No. Posted to Course Website
Materials	2	2
Axial Loads	3	3
Torsion	2	2
Stress and Strain Transformation	2	2
Bending	2	2
Buckling	2	1
Combined Loads	2	2
TOTAL	**15**	**14**

Based on results from Felder's learning styles inventory,[19] the 28 students who completed the inventory were predominately active/sensing/visual/sequential learners (see Figure 7) which is similar to the "average" engineering student[20]. The average creativity score from the TestMyCreativity survey[21] was 60.1 (the typical score is 63.6) with the lower-than-average contributing metrics being curiosity, boldness, and connections. The average results from the creativity survey are shown as the solid red line in Figure 8. In this figure, +/- 1 standard deviation from the average are shown as the red dotted lines and the typical results, according to the website, are shown as the black dashed line. Learning style and creativity results were similar to the MC300 students.

Table 5 Summary of Student-Generated Review Content (MC364)

		Format			Included					Creativity	
Topic	**LSI* (Creativity)**	**Slides**	**Summary Sheet**	**Video**	**Concepts / Def'ns**	**Derivations**	**Equations**	**Example Problem**	**Common Errors**	**Format**	**Content**
Materials 1	R/S/Vi/G (70.4) A/S/Vi/S (62.5)		X		X						
Materials 2	A/I/Vi/S (60.2) R/S/Vi/S (52.9)	X			X			X		X	
Axial Loads 1	no surveys A/S/Vi/S (62.7)	X			X			X	X		
Axial Loads 2	R/S/Vi/S (61.4) A/S/Vi/S (52.8)			X	X		X	X	X	X	
Axial Loads 3	A/S/Vi/S (62.7) A/S/Vi/S (65.5)		X		X		X	X			
Torsion 1	R/S/Vi/S (70.4) R/S/Vi/S (57.3)	X			X		X	X			
Torsion 2	R/S/Vi/S (55.0) A/S/Vi/S (50.3)	X					X	X		X	
Stress & Strain Transformation 1	no surveys R/S/Vi/G (64.4)	X			X		X	X	X		
Stress & Strain Transformation 2	A/S/Vi/S (51.7) A/S/Vi/S (59.6)	X					X	X			
Bending 1	A/S/Vi/G (63.5) R/S/Vi/S (55.9)	X			X		X				
Bending 2	A/S/Vi/S (79.1) R/I/Vi/G (56.0)	X			X	X	X	X			
Buckling 1	R/S/Vi/G (53.3) A/S/Vi/S (76.3)	X					X				
Buckling 2 NOT POSTED	A/S/Vi/S (57.2) A/S/Vi/S (54.6)			X	X		X			X	X
Combined Loads 1	R/S/Vi/S (54.2) A/S/Vi/S (75.8)	X			X		X				
Combined Loads 2	A/S/Vi/S (50.4) A/S/Vi/S (64.1)	X			X		X				

*Learning Styles Inventory Results: [**A**ctive or **R**eflective] / [**S**ensing or **I**ntuitive] / [**Vi**sual or **Ve**rbal] / [**S**equential or **G**lobal]

The course had a total of 107 students enrolled: 57 (53%) accessed the review products at least one time during finals week. Interestingly, as Table 6 shows, students who opened or downloaded one review product, opened or downloaded all available products. This was true without exception. Of the 30 students who generated content, 17 (57%) accessed content created by others and the remaining did not access any of the review content – nearly the same usage rate as the entire course population. Unlike the observation from the MC300 data, this suggests that creating the review content did not affect the propensity to use student-generated content when the assignment was required.

Table 6 Average Number of Students Who Opened Products within each MC364 Topic Area

Topic Area	No. of Students
Materials	57
Axial Loads	57
Torsion	57
Stress and Strain Transformation	57
Bending	57
Buckling	57
Combined Loads	57

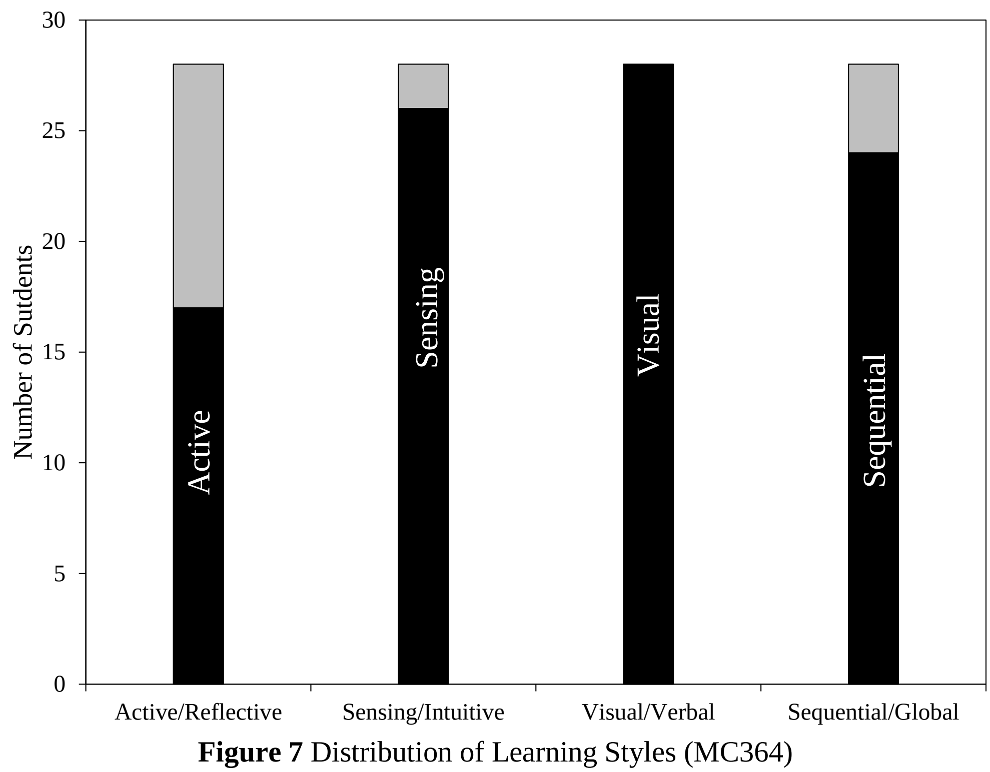


Figure 7 Distribution of Learning Styles (MC364)

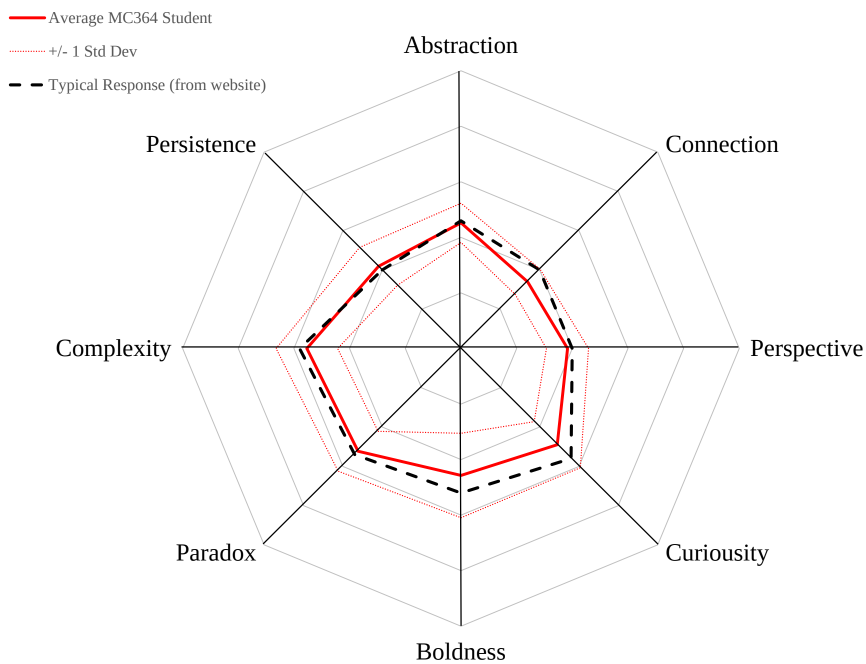
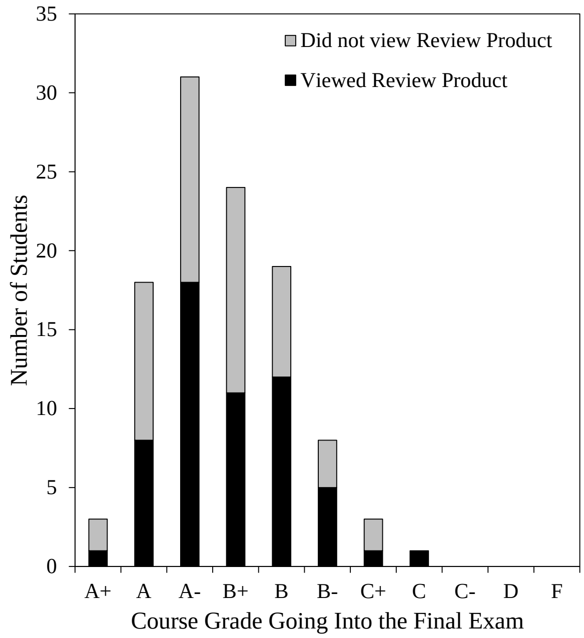


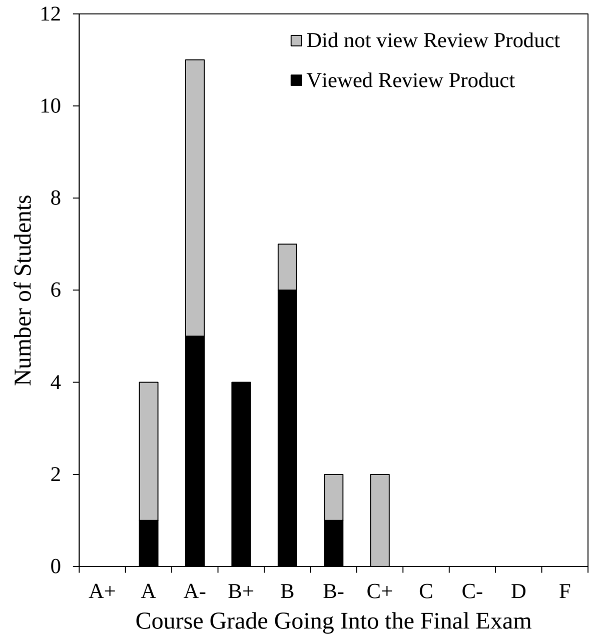
Figure 8 Average Creativity Score (MC364)

Figure 9 shows usage preferences by the grade the students had going into the final exam. While we expected to see those students with lower grades use the resources at higher rates, they did not do so (within the limits of statistical significance): the student-generated review content was used nearly equally by students of all aptitudes.

The review products were made available to all students on 10 December 2015 in preparation for the final exams scheduled on the morning of 15 December (for 25 students) and the evening of 17 December (for 82 students). As Figure 10 shows, the students accessed the review material in largest numbers the day before and the day of the exam. This figure also shows the equal use among all topics – if a student opened one review product of any topic, they opened all products of all topics.



(a)



(b)

Figure 9 Usage Based on Grade Going Into the Final Exam:
(a) Entire MC364 Course Population and (b) Students Who Generated Content

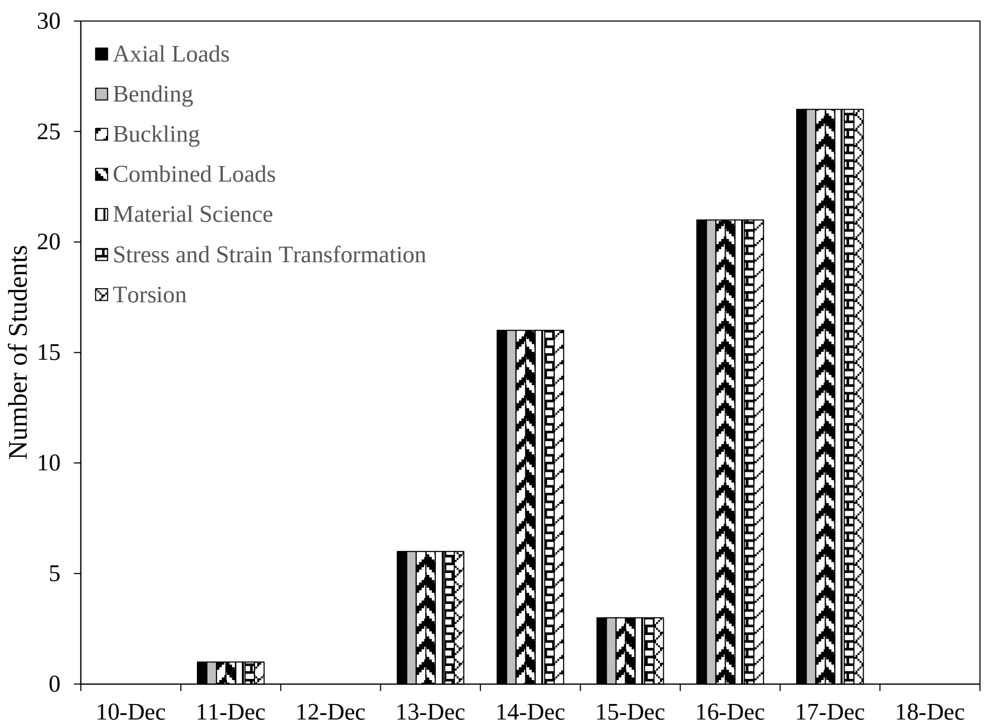


Figure 10 Review Content Usage by Date

Summary

This first iteration of student-generated review products in two introductory mechanics courses was instructive in several ways. As described above, the data provides insights into student creativity and the propensity to use student-generated content.

More of the submitted products were judged as creative when the assignment was voluntary (i.e. an extra credit opportunity): 14 of the 34 submissions in MC300 (41%) compared to 4 of 15 submissions in MC364 (27%). This offers insights into student motivation to go above and beyond or showcase their creativity and may indicate that naturally creative students respond well to optional assignments when they are specifically encouraged to demonstrate creativity. The value of the TestMyCreativity survey is questionable from this project. Of the seven MC300 students who scored above average on this survey, only two submitted products judged creative by the instructors, while some of the lowest scoring students on this creativity index submitted some of the most creative products. In MC364, none of the eight students with higher than average creativity scores submitted products judged creative and the most creative product was submitted by two students with well-below-average scores. There were no apparent trends regarding the influence of learning style preferences on submission creativity.

The propensity to use the review products appears to be slightly greater among students who submitted assignments when the assignment was voluntary (i.e. an extra credit opportunity) (63% in MC300; 57% in MC364). There is no apparent difference on the population of students who did not submit a review product but did access the products (roughly 50% in both courses). Unexpectedly, there was no apparent influence of course grade going into the final exam on the likelihood of accessing the review products: they were used nearly equally among all performance levels. Not surprisingly, the likelihood of viewing review products spiked in the day or two immediately prior to the final exam.

Future Work

This paper reports the initial iteration of this assignment in two mechanics courses. The authors intend to improve the assignment and implement it in both courses during the Fall 2016 semester. The assignment will be re-written and the rubric updated to emphasize the instructors desire for students to showcase their creativity. Additionally, the assignment will be announced at the beginning of the semester in an effort to provide students more time to consider the best ways to present the information in a way that will engage other students.

The assessment of future iterations will include the same components as this iteration plus additional investigation of the influence the use of student-generated content may have on student learning as measured by performance on exams. Exactly how to measure this effect on learning is still in development but may include use of predictive models based on incoming GPA as described by Bruhl et al.[22]

This assignment required effort from the instructors beyond providing feedback to the students about their assignments. More efficient methods of uploading content to the course websites will be investigated which will reduce the time-cost to instructors while still providing the educational opportunity to the students.

Assessment of student opinions regarding their perceived value of both preparing review material and using material prepared by other students will be an important part of future iterations. This can be gathered as part of course-end-feedback and can provide valuable insights into student perceptions which can then be compared to observed usage trends.

Conclusions

This paper described observations from an initial implementation of student-generated course review material during the Fall 2015 semester in the first two mechanics courses taken by engineering students at USMA (MC300 and MC364). Near the end of the semester, students were given an assignment to create a study aid. This assignment was an optional extra credit opportunity open to all 200 students in MC300 and required for two sections (30 students) enrolled in MC364. The assignment was designed to encourage creativity and effective communication of technical content. Study aids were created by groups of 2 or 3 students on a specific topic from the course and the types of products included: short instructional videos, worked solutions to example problems, topic outlines, and written summaries of the material. Once vetted by the instructors, these student generated tools were posted to the course web page and made available to the rest of the students to use during final exam preparation.

Approximately half of all students enrolled in both courses accessed the student-generated products in the days immediately prior to their final exam. Students who created content were slightly more likely to access other products – this was most apparent for the students for which the assignment was voluntary. Students from all levels of aptitude, as measured by current performance in the course prior to the final exam, used the review products.

This initial implementation demonstrated value and usefulness of student-generated content as review material for mechanics courses. Improvements to the assignment instructions and detailed planning of needed assessment data will help future iterations of this assignment even more meaningful. Creating more opportunities for engineering students to practice and demonstrate creativity and effective communication is vital to their development as engineers who will create the technological innovations of the future. Student-generated content can play a role in doing this.

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APPENDIX A – MC300 Assignment

MC300, AY 16-1
"**Help me help you!**" Student Generated Course Review Material
Due: submit via e-mail to your instructor NLT the ***START of Lesson 40***
20 Point Extra Credit Assignment

Assignment: Create a product which summarizes, reviews, or covers the main content from one of the primary blocks of instruction in MC300.

Purpose: To assist all MC300 students in reviewing content from the course, cementing concepts in their minds, and preparing for the TEE.

Details: Working in groups of two students, create a product which summarizes, reviews, or covers the main content from one of the following major topics in MC300:

1) 2D Equilibrium
2) Truss analysis
3) Hooke's Law
4) Material Properties
5) Axial Deformation
6) Buckling
7) Frame Analysis
8) Shear and Moment Diagrams
9) Beam Deflection

Distribution: All products, after being reviewed by your instructor for accuracy, will be posted on Blackboard for access by all MC300 students as they review the course and prepare for the TEE.

Examples of products include, but are not limited to: short instructional videos, mind maps of topics, worked solutions to example problems, topic outlines, analogies / metaphors to be used as memory aids, or written summaries of the material. Use your creativity to generate a product that you would find useful when reviewing the course material. Consider ways to make your product engaging and interesting.

In addition to submitting the product you create, also submit a pdf of your results from two on-line surveys. Each survey should take less than 10 minutes to complete (each has about 40 questions to answer). The results of the surveys will not be shared with other students or faculty.

1. Learning Styles Inventory (https://www.engr.ncsu.edu/learningstyles/ilsweb.html). You are encouraged to consider the results of the inventory and what it means in the context of how you learn most effectively and what you can do to improve how well you learn (see http://www4.ncsu.edu/unity/lockers/users/f/felder/public/ILSdir/styles.htm).
2. Creativity Survey (http://www.testmycreativity.com/). You are encouraged to consider your score in each of the creativity metrics and consider ways to become even more of a creative thinker and problem solver.

Appendix B – MC364 Assignment

MC364, AY 16-1

"**Help me help you!**" Student Generated Course Review Material

Due: submit via e-mail to your instructor NLT 1600 on 08 DEC

50 Point Assignment

Assignment: Create a product which summarizes, reviews, or covers the main content from one of the primary blocks of instruction in MC364.

Purpose: To assist all MC364 students in reviewing content from the course, cementing concepts in their minds, and preparing for the TEE.

Details: Working in groups of two students, create a product which summarizes, reviews, or covers the main content from one of the following major topics in MC364:

1. Materials (phase diagrams, phase transformations, strengthening mechanisms)
2. Axial loads (indeterminate, inelastic, thermal stresses, normal and shear stress)
3. Torsion (indeterminate, inelastic)
4. Stress and strain transformation (principal stresses, Mohr's circle, strain rosettes, generalized Hooke's Law)
5. Bending (normal and shear stress derivation, indeterminate, inelastic, deformation by direct integration)
6. Buckling (Euler's buckling equation, braced columns)
7. Combined loads

Distribution: All products, after being reviewed by your instructor for accuracy, will be posted on Blackboard for access by all MC364 students as they review the course and prepare for the TEE.

Examples of products include, but are not limited to: short instructional videos, mind maps of topics, worked solutions to example problems, topic outlines, analogies / metaphors to be used as memory aids, or written summaries of the material. Use your creativity to generate a product that you would find useful when reviewing the course material. Consider ways to make your product engaging and interesting.

In addition to submitting the product you create, also submit a pdf of your results from two on-line surveys. Each survey should take less than 10 minutes to complete (each has about 40 questions to answer). The results of the surveys will not be shared with other students or faculty.

3. Learning Styles Inventory (https://www.engr.ncsu.edu/learningstyles/ilsweb.html). You are encouraged to consider the results of the inventory and what it means in the context of how you learn most effectively and what you can do to improve how well you learn (see http://www4.ncsu.edu/unity/lockers/users/f/felder/public/ILSdir/styles.htm).
4. Creativity Survey (http://www.testmycreativity.com/). You are encouraged to consider your score in each of the creativity metrics and consider ways to become even more of a creative thinker and problem solver.