Mechanics Knowledge Enhanced with Videos Illustrating Concepts Experienced with Hands-on Activities

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Assessing Improvement of Student Mechanics Understanding through Supplementary Videos

Abstract

The use of hands-on activities has been proven in the past to be an effective pedagogical strategy. Many of the concepts taught in engineering undergraduate courses are counter intuitive and, especially in a time when students interact less intensively with real world applications, exposure to models are essential for learning. Recognizing this need, a first year mechanics course at the University of Waterloo has already implemented the use of seven hands-on activities. However, time limitations resulted in students participating in only two out of the seven activities. Each group of students experienced two different activities from the rest of the class, in other words not all of the students in the class experienced the same activities. Instructional videos were developed to provide students with an alternative way to understand each of the models and their related concepts. The videos are also used as a teaching approach to show students how mechanics concepts are applied. Learning takes place through a combination of observational learning, experiential learning, activity preparedness, and reflective learning. Upon completion of two out of the seven activities, the students were shown one of the videos during class and guided to the rest of the video series to watch on their own. Students were able to gain greater perspective on the activities they participated in. For those activities they were unable to interact with, they had the opportunity to learn about the same concepts through an alternative but comparable experience. Thus, all students were able to utilize a unique resource to improve their understanding of the material in ways that could not be achieved during lectures or tutorials. The study of the videos' overall success was carried out primarily by means of a comprehensive subjective survey sent to students after they watched the videos. The survey asked for their overall thoughts, how they found the video quality, about the ways in which the videos improved their learning, and for them to rate their knowledge on a series of key concepts covered by the videos. View counts for each of the videos over the period of study were also examined to gain an understanding of student participation. Positive results found for both measures demonstrate the effectiveness of the various techniques incorporated into the videos and their success as an additional learning tool in a first year mechanics course.

Introduction

The fall of 2018 saw the implementation of a series of videos into a first year mechanics course for students in civil, environmental, geological, and architectural engineering programs at the University of Waterloo. The course introduces students to key mechanics concepts that continue to be built upon in upper years. In order to provide a better feel for the theory presented in lectures, students participate in hands-on classroom activities, where each activity incorporates the use of a physical model designed to address a fundamental concept. Due to time constraints, students have only been able to experience two of the seven models. The proposed solution was to create videos based around each activity to allow students to engage and learn from the five other activities outside of class. A total of ten videos were produced that parallel the key steps in the activities, bring further perspective, and provide a broader context for students to reflect on their own experiences. The videos cover a wide range of topics such as equilibrium of forces, arches and chains, suspension bridges, gothic cathedrals, and soil and water pressure. A comprehensive list of the videos and links to view them online can be found in Appendix A.

Students were introduced to the videos after they completed the in-class activities. Small groups were formed and assigned one of the activities to work on during their tutorial and write an accompanying report. These groups were later able to experience one of the other activities and asked to create a video report. After both activities and reports were complete, about two months into the term, students were shown one of the videos during class. They were also directed to the other videos and encouraged to watch them on their own time outside of class. Once everyone had an opportunity to watch the videos, a quiz was given based on the content of the activities, for which students answered questions only about the activities their group participated in during class. Around this time they were also sent a survey to provide their opinions about the videos and reflect on how they may have impacted their learning.

Background

The concept of supplementing student learning with course content based videos has been previously explored by many [1] - [3]. Through various means the benefits they can pose, along with alternative methods that can be utilized to assess such benefits, have been determined [3] - [8].

With students already being exposed to material through lectures, it is important to consider the ways in which the videos are able to add value to the course outside of simply providing content. [1] supports the comparable nature of using video resources to in-class instruction. They explain that using videos to model a problem and a procedure are “effective for acquiring new skills and may enhance the confidence learners have in their own capabilities to perform the modeled task.” The capacity for videos to impart students with these more action-based abilities demonstrates the effectiveness for their use with the model activities, which are largely physical and based around students working through a series of steps. Moreover, [2] mentions that using a video would allow for a teaching strategy that would re-establish classroom content in a context outside the confines of the “rush of minute-to-minute practice.” They found through research that videos are a “focal tool for supporting the collaborative reflective process.” This emphasizes how videos allow for deeper learning during the activity and in future courses through reflective learning.

[3] describes the process of creating effective instructional videos as four steps: planning, development, delivery, and reflection. They stress the importance of reflection through getting feedback from students for effective evaluation, where success can be measured by anonymous student surveys that ask questions about the course and videos. This ties in with their view on the importance for constant improvement and continually working to provide better resources for student learning. This emphasizes the importance of recognizing that the process of creating videos does not end once they are made available for use, but continues into the vital stage of

receiving feedback and measuring their success by different metrics. Depending on the primary goal one has in creating course-based videos, varying methods have been used to assess their success and pinpoint areas for improvement. As demonstrated by [4], a useful metric for evaluation can be the amount of views associated with each video. In addition, some researchers [4] - [8] have implemented surveys as a principal means of assessing success from the student perspective. As done by [4], [6], [7], these surveys may incorporate a series of statements about the videos for which students are instructed to indicate their agreement based on a Likert scale. Similar to the link between the classroom activities and the developed mechanics videos, the connection between hands-on lab work and the use of related videos has been explored in the research of [5] - [7] by various methods.

Video creation process

The overall effectiveness of the videos can largely be attributed to the process taken to create the series. The people involved, methods incorporated, general approach, and various techniques had a great impact on the final result.

For instance, the diversity of those within the team that worked to develop the videos was imperative in ensuring they were easily accessible for all viewers. The team was composed of those coming from various backgrounds in terms of content knowledge, including professors of mechanics courses, a student with first year knowledge of mechanics, and others with video production experience, but little previous exposure to the topics explored in the videos. The wide range of perspectives this provided led to a final product that was inclusive to all previous levels of knowledge. There was also differences amongst the group with respect to language, with one person on the team offering the perspective of having learned English as a second language. This was helpful at many points in identifying how the use of language may pose a possible barrier to certain students, and determining how best to word explanations to ensure understanding for all.

As described by [9], an important aspect of the videos was having them recreate the experience of the activities. This was achieved in part through focus during the planning stages on the student activity instructions. They were used as a starting point in the high-level planning of each video, with the entire group going through the activity step-by-step to get a feel for the student experience and determine key moments to incorporate. The planning was also highly focused on determining the best examples to include that the majority of students could relate to. This was done in order to illustrate the ideas and provide students with a gut-feel similar to that provided by participating in the class activities.

[9] also discussed the influence of video design on increasing the efficiency of class time spent on the activities. The videos aimed to focus on activity process and illustrating the procedure in a similar format as would be followed in the tutorial. Videos were filmed with people shown physically interacting with the models for students to get a sense of their role in completing the activity during class. Moreover, the planning for all videos included determining how to incorporate the use of images, text, and speech to help reinforce key concepts and improve retention.

[9] proposed reflection as another key consideration during creation, along with its ability to help students deepen their understanding of mechanics concepts. This was addressed primarily by the inclusion of carefully considered questions, for which viewers are instructed to pause and reflect on. This technique aims to prompt those watching to recall their prior knowledge and recognize any instincts they might have about a concept before it is fully explained.

The videos were further shaped by the intention that they may function as a study tool. [9] elaborated on how the videos were organized to follow the most logical order for targeted studying, which was based on the assumption that students would watch these videos to prepare for assessments. Moreover, in terms of length, steps were taken to ensure that all concepts were covered in the shortest amount of time to enable more efficient studying. This optimal length varied by video depending on the nature of the concepts covered, but they are consistent in that none of them exceed ten minutes. Also, the questions incorporated into the videos were considered in the context of self-assessment during review. They were designed to provide students with an indication of which areas they may be lacking sufficient understanding in and should focus their efforts on.

Video views

The number of views received by each video was collected and analyzed to get a sense of how they were received overall and relative to one another. The ten videos were uploaded in March of 2018, and the students were formally introduced to them around mid-November of that year. These students then completed the course in December, about a month later. Table 1 summarizes the number of views by video. It includes those that occurred after they were first uploaded in March 2018 up until November 1st, 2018, as well as the combined total over the months of November and December 2018. Unfortunately, the public availability of the videos makes it difficult to discern which of those views came from students enrolled in the courses of study. However, a large increase in views seen by all the videos during the months of November and December, compared to those observed over the seven month prior, suggests that many students watched the videos. Additionally, these numbers on their own are a valuable indicator of the effectiveness of the videos. Their ability to garner such viewing, even before they were tied into the course, demonstrates they are likely being well received. It can also be noted from this data that certain videos stand out as more popular than others, with suspension bridges, gothic cathedrals, retaining walls, and arches and chains showing a significantly greater number of views in comparison to the others. Such a large difference is interesting to see, and could perhaps be a point to explore in the future by asking students for reasons they may have watched some of the videos but not others, and how they felt the videos compared in a general sense. Overall the viewing data indicates that students were watching the videos, and that they were successful from a watchability perspective.

Table 1: Number of views by video

Video Title	Cumulative Views Before November 2018	Total Views During November and December 2018
Suspension bridge	7262	12535
Equilibrium of a Point	150	728
Equilibrium of a Body	176	885
Gothic Cathedrals	168	1554
Tunnels and Culverts	339	641
Silos and Tanks	326	498
Retaining Walls	1015	3442
Dams	555	885
Soil and Water Pressures	1688	1951
Arches and Chains	931	3734
Total	12610	26853

Survey results

The feedback provided by the students through a shared survey gave great insight into the reception of the videos and their overall success. The survey aimed to assess various aspects of the videos from general quality to how they impacted learning. For a complete list of survey questions, see Appendix B.

The survey was made available to all students in civil, environmental, geological, and architectural engineering enrolled in first year mechanics for the fall 2018 term. Although highly encouraged, the survey was not mandatory and thus the results only take into account the opinions of those who did respond. A total of 250 students completed the survey out of 322 who were enrolled in the involved courses, giving a response rate of about 78%. Response rates remain fairly consistent across programs, with the highest participation observed by Architectural Engineering students and the lowest amongst the Environmental Engineers.

The first section of the survey consisted of questions that gauged the students' overall thoughts about the videos. A five-point Likert scale was used to ask questions about how interesting and engaging they found the videos, how useful the videos were for learning the course content, and how satisfied they were with the overall quality and effectiveness of the videos. For each of these questions over 85% of respondents answered with the two most positive options (4 or 5). These results indicate overall success in creating videos that were effective from the student's perspective, as the responses largely imply that student's felt positively towards the videos. A further breakdown of these results are provided in Table 2.

Table 2: Survey overall thoughts section responses by question (n = 250)

Question	Responses				
How interesting and engaging are the videos?	Not at all interesting	Not very interesting	Neutral	Somewhat interesting	Very interesting
	0.81%	2.42%	10.89%	47.58%	38.31%
How useful were the videos for learning the course content?	Not at all useful	Not very useful	Neutral	Somewhat useful	Very useful
	0.81%	2.02%	8.47%	33.06%	55.65%
How satisfied were you with the overall quality and effectiveness of the videos?	Very dissatisfied	Dissatisfied	Neutral	Satisfied	Very satisfied
	0.81%	0.40%	8.87%	36.69%	53.23%

Questions relating to the video structure were also included, with students asked to indicate how they felt about the length of the videos and their pacing. In terms of video length, the goal during production was to keep them each under ten minutes, with final video lengths for the ten videos ranging from 2:26 to 9:27 minutes. Table 3 summarizes the results from these questions by the percentage of students who answered with each option. The survey revealed that the majority, which was about 80% of students, felt the length of videos to be sufficient. Moreover, those who answered differently showed a slight tendency towards feeling the videos were too long, while no one found the videos to be too short. Similar results were found for video pacing, with 77% of respondents indicating that they felt the pacing to be sufficient. Those who felt differently were of the opinion that the videos were paced slightly too slow, while none found them to be too fast.

Table 3: Video length and pacing survey question responses (n = 250)

Question	Responses				
How did you find the length of the videos?	Very short	Slightly too short	Sufficient	Slightly too long	Very long
	0.00%	7.26%	79.84%	11.69%	1.21%
How did you find the pacing of the videos?	Very slow	Slightly too slow	Sufficient	Slightly too fast	Very fast
	1.21%	14.52%	77.02%	7.26%	0.00%

Another section of the survey looked at student opinions of the videos in terms of overall quality, again utilizing a five-point Likert scale corresponding to level of agreement with the provided statements. This was an important factor to consider given that the quality of the videos greatly impacts their learning value. [10] states that videos have the “ability to capture the richness and complexity” of classroom instruction. However, this can only be done with the setting of a clear plan and modifying the video continually as it is developed to ensure optimal production. Then the viewer will not be distracted by noticeable discontinuities or technical imperfections, but instead the video will be effective in conveying its message at multiple levels and in ways that the viewer will remember. To assess how well the videos were able to achieve this, the statements outlined in Table 4 were provided. As shown in the table, the first five statements reported that over 80% of students responded with agree or strongly agree. For the sixth statement, which gauges whether the videos were able to hold their attention, only about 69% gave those same responses. These results demonstrate that the quality of videos was perceived to be fairly high and met most of the basic requirements for engaging students and encouraging their continued use. While such criteria is not necessarily indicative of reflection, learning, or retention of material, such qualities are important in allowing for the videos to improve understanding and use of the resource. The drop in positive response with respect to how well the videos held the students' attention should be explored further. The results were due to more neutral responses and were not necessarily poor, but it would still be helpful to understand why they are not able to hold complete attention of the viewer, and determine whether there are changes that could be made to improve on this front.

Table 4: Student survey level of agreement for statements about video quality (n = 250)

Statement	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
The narration in the videos are clear and engaging.	0.81%	3.23%	11.29%	50.00%	34.68%
The visuals in the videos are of satisfying quality.	0.00%	1.21%	8.87%	38.71%	51.21%
The video events are in a logical order.	0.00%	1.61%	8.06%	47.18%	43.15%
The language used in the videos are at my level of understanding.	0.00%	0.40%	6.05%	39.11%	54.44%
I found the videos easy to follow.	0.40%	0.00%	8.47%	37.50%	53.63%
The videos held my attention while watching.	1.61%	4.03%	25.40%	43.95%	25.00%

The primary focus of the survey was to determine whether the videos were successful in supporting student learning. More specifically, it was of interest to evaluate the effects of the elements that were incorporated into the videos with the primary intention of developing understanding and mimicking the in-class activity experience. As with previous sections, students were asked to respond to a series of statements and indicate their level of agreement using a five-point Likert scale. These statements and their results have been summarized in Table 5.

Table 5: Agreement with survey statements about student learning (n = 250)

Statement	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
The videos improved my conceptual understanding of the topics discussed.	0.00%	2.02%	14.57%	51.82%	31.58%
The explanations within the videos were clear to understand.	0.00%	0.40%	5.67%	47.77%	46.15%
The explanations within the videos were relatable.	0.00%	2.83%	16.19%	44.53%	36.44%
The combination of verbal and visual elements made it easier for me to grasp new concepts.	0.00%	0.40%	10.12%	39.68%	49.80%
I found the questions that were asked in the videos to be helpful.	0.81%	3.64%	25.10%	42.91%	27.53%
The videos increased my interest and curiosity about the topics they discussed.	0.40%	5.26%	25.10%	41.70%	27.53%
The videos helped to answer some of the questions I had prior to watching them.	1.21%	5.26%	20.24%	43.72%	29.55%
The examples used in the videos were helpful in furthering my understanding of the concepts.	0.40%	1.21%	12.15%	51.42%	34.82%
The concepts in the videos were similar in process and understanding to the activities done in class/tutorial.	0.00%	2.02%	10.53%	42.91%	44.53%

Overall, the results of the learning section reflect that the videos were able to achieve what they set out to accomplish. Generally positive feedback was found, with agree and strongly agree responses reported as the most common, followed by neutral, and with comparatively very few responses of disagree or strongly disagree. For the most part, responses proved more positive than expected, as students appear to have connected and responded well to many of the aspects of the video that had been carefully considered during the planning process. The first statement was "the videos improved my conceptual understanding of the topics discussed," for which positive responses demonstrate that the main goal of the videos, to deepen their understanding of the concepts, was successful. With respect to the ability of the videos to become a useful study tool, this is exemplified by the high percentage of agreement with the statement that "the explanations within the videos were clear to understand." The video creation process put great focus on carefully choosing examples to demonstrate the key concepts of a topic. To judge how students felt about these examples, the survey inquired whether students found the explanations within the videos to be relatable and if the examples used were helpful in furthering their understanding of the concepts. The high percentage of agreement revealed by the survey indicates that the examples within the videos improved connection to concepts. Further, it points to how they helped to mimic activity experience, which had been previously lost to those unable to work with a given activity hands-on in the tutorial. Another important element of the videos was the combination of verbal and visual elements, and students responded that this made it easier for them to grasp new concepts. This demonstrates that the videos were successfully able to make efficient use of time, as the use of both elements was clearly helpful for students, while also working as a strategy to convey more information in less time.

Questions were considered to be instrumental to the videos during the planning phase. Careful consideration went into the questions that were incorporated into the videos in an attempt to encourage reflection. The high amount of student responses reporting that the questions were helpful implies that they were a useful tool and that asking students to reflect while learning through videos can be an important factor in improving understanding. This notion of reflection was further explored and verified by agreement with the statement: “the videos helped to answer some of the questions I had prior to watching them.” The survey went on to ask students if the videos increased their interest and curiosity about the topics they discussed. Feedback indicated agreement as the consensus, which supports the idea that the videos work as a complement to the activities. A fundamental aspect of the models was their ability to encourage curiosity and build interest in mechanics, and now the videos act as a response to that. Finally, the survey asked students whether they felt the concepts in the videos to be similar in process and understanding to the activities done in class/tutorial. The positive response demonstrates the videos to be a sufficient alternative for students when they cannot experience the models first-hand. It also reveals the possible value they could bring in the future if students were instructed to watch them before participating in the tutorial activity. The comparable nature indicates that they would likely improve efficiency for this case.

An additional method was incorporated into the survey to assess how well students were able to grasp various concepts covered through the videos. Students were asked to provide a rating on a scale from one to ten to describe their level of knowledge for a series of given topics. A rating of one corresponded to possessing little knowledge of the topic, while a rating of ten demonstrated a high level of understanding. Upon review of the responses, it was revealed that the average rating was a seven or eight for each of the concepts. A complete list of concepts included in the survey can be found in Appendix B. Some examples of these included representing a force using a vector, the relationship between an arch's shape and the loads that it carries, and the most efficient distribution for reinforcements along a silo. The fairly high average response shows that students feel confident in their knowledge of the course topics. While it is likely in part due to the videos, this data on its own is not entirely reflective of the videos’ success, since it is not known how students would have felt without the videos as a resource. Thus, a true understanding of this data and further context would require future surveys that ask students these questions before and after viewing the videos.

The final survey question asked respondents whether they would watch the videos again in the future. Approximately 74% indicated the possibility of viewing them again, demonstrating that the majority of the students found the videos to be of some value, which was essentially the goal of their creation.

Recommendations for future work

The data collected from the survey is valuable in many respects, although there still remains a great deal of work that could be done in the future to better understand the impacts of incorporating the videos into the course.

One of the plans for the future is to evaluate the effects of reversing the order by which students are exposed to the videos and activities. It would allow the effects of showing the videos before students complete the activities to be explored relative to performance, learning, and efficiency during the tutorial. [5] assessed a similar case, comparing lab efficiency between a group who viewed related videos prior to performing a lab and a group which had not. They found that it took students less time to complete the lab when they were provided with videos to watch beforehand.

Another important aspect to reconsider for subsequent video implementation is the content of the survey provided to students. As done by [4], [7], [8], the inclusion of open response questions should be incorporated into the survey. The specific details, such as what questions to ask and how many to include remain to be determined, but it is clear from the previously mentioned works that they add a great deal of value to the reflection process. In addition, they allow respondents to comment on aspects that may be overlooked in other parts of the survey. It could also be of use to ask students how many times they watched the videos, as was done by [6], whose survey allowed for respondents to answer that they had watched the videos never, once, two times, three times, or more than three times.

[4] incorporated surveys to be completed at the beginning and end of the semester that rated confidence to determine self efficacy improvement. A similar method could be of use in the future to build upon the current survey questions that aimed to gauge student understanding through rating their level of knowledge. Self efficacy would be a similar, but perhaps more meaningful measurement, as students would be able to more accurately self-report this on a survey. It would also provide a great deal more insight to have numbers that can be compared, and thus provide a more accurate sense of video influence on student learning.

In addition to the more qualitative, opinion based data provided by the survey, it may be helpful to incorporate assessments that more directly illustrate how the videos improve understanding of concepts. While the survey incorporated student self-assessment of knowledge, the use of a more objective gauge would likely be of greater value. As described in the work of [8], a questionnaire consisting of a series of multiple choice questions about the concepts could be used to assess knowledge. This idea is expected to be taken a step further in later years to assess memory retention through the use of iClicker questions, which will be based on each of the activity topics and asked in upper year mechanics courses. The average number of correct responses will be taken as an indication of how much knowledge was retained.

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Appendix A: Links to Engineering Models Videos

1. Equilibrium of a Point: https://www.youtube.com/watch?v=a2IX52UlCWE
2. Equilibrium of a Body: https://www.youtube.com/watch?v=6zXkYjmvLuI
3. Arches and Chains: https://www.youtube.com/watch?v=JlL6ZHChhQE
4. Suspension Bridges: https://www.youtube.com/watch?v=caTaBeKUh-U
5. Gothic Cathedrals: https://www.youtube.com/watch?v=WiX2amY7G-I
6. Soil and Water Pressures: https://www.youtube.com/watch?v=mpV8-YaJ2p4
7. Dams: https://www.youtube.com/watch?v=NaVCKTYQEr4
8. Retaining Walls: https://www.youtube.com/watch?v=iDzp6xEAT2I
9. Silos and Tanks: https://www.youtube.com/watch?v=YZVIRILUkCc
10. Tunnels and Culverts: https://www.youtube.com/watch?v=62-pK2ISlv4

Appendix B: Survey Questions

My program is:

Civil Engineering	Environmental Engineering	Geological Engineering	Architectural Engineering

The activities I have done in the tutorial are (please select maximum of two):

Suspension Bridge	Arches	Gothic Cathedrals	Culverts/Silos	Dams/Retaining Walls

Please indicate your opinion on the question below.

How interesting and engaging are the videos?

Not at all interesting	Not very interesting	Neutral	Somewhat interesting	Very interesting

How useful were the videos for learning the course content?

Not at all useful	Not very useful	Neutral	Somewhat useful	Very useful

How satisfied were you with the overall quality and effectiveness of the videos?

Very dissatisfied	Dissatisfied	Neutral	Satisfied	Very satisfied

How did you find the length of the videos?

Very short	Slightly too short	Sufficient	Slightly too long	Very long

How did you find the pacing of the videos?

Very slow	Slightly too slow	Sufficient	Slightly too fast	Very fast

Please indicate your level of agreement with each of the following statements:

The narration in the videos are clear and engaging.

Strongly disagree	Disagree	Neutral	Agree	Strongly agree

The visuals in the videos are of satisfying quality.

Strongly disagree	Disagree	Neutral	Agree	Strongly agree

The video events are in a logical order.

Strongly disagree	Disagree	Neutral	Agree	Strongly agree

The language used in the videos are at my level of understanding.

Strongly disagree	Disagree	Neutral	Agree	Strongly agree

I found the videos easy to follow.

Strongly disagree	Disagree	Neutral	Agree	Strongly agree

The videos held my attention while watching.

Strongly disagree	Disagree	Neutral	Agree	Strongly agree

Please indicate your level of agreement with each of the following statements:

The videos improved my conceptual understanding of the topics discussed.

Strongly disagree	Disagree	Neutral	Agree	Strongly agree

The explanations within the videos were clear to understand.

Strongly disagree	Disagree	Neutral	Agree	Strongly agree

The explanations within the videos were relatable.

Strongly disagree	Disagree	Neutral	Agree	Strongly agree

The combination of verbal and visual elements made it easier for me to grasp new concepts.

Strongly disagree	Disagree	Neutral	Agree	Strongly agree

I found the questions that were asked in the videos to be helpful.

Strongly disagree	Disagree	Neutral	Agree	Strongly agree

The videos increased my interest and curiosity about the topics they discussed.

Strongly disagree	Disagree	Neutral	Agree	Strongly agree

The videos helped to answer some of the questions I had prior to watching them.

Strongly disagree	Disagree	Neutral	Agree	Strongly agree

The examples used in the videos were helpful in furthering my understanding of the concepts.

Strongly disagree	Disagree	Neutral	Agree	Strongly agree

The concepts in the videos were similar in process and understanding to the activities done in class/tutorial.

Strongly disagree	Disagree	Neutral	Agree	Strongly agree

Rate your level of knowledge on the following.

Equilibrium Part 1: Forces at a Point

Representing a force using a vector.

1 (Low)	2	3	4	5 (Medium)	6	7	8	9	10 (High)

Adding vectors graphically.

1 (Low)	2	3	4	5 (Medium)	6	7	8	9	10 (High)

The condition that the forces acting on a point must satisfy for equilibrium.

1 (Low)	2	3	4	5 (Medium)	6	7	8	9	10 (High)

Equilibrium Part 2: Forces on a Body

The two conditions that the forces acting on a body must satisfy for equilibrium.

1 (Low)	2	3	4	5 (Medium)	6	7	8	9	10 (High)

The principle of concurrent forces.

1 (Low)	2	3	4	5 (Medium)	6	7	8	9	10 (High)

A moment and what determines its magnitude.

1 (Low)	2	3	4	5 (Medium)	6	7	8	9	10 (High)

Arches and Chains

The relationship between an arch and a chain.

1 (Low)	2	3	4	5 (Medium)	6	7	8	9	10 (High)

The relationship between an arch's shape and the loads that it carries.

1 (Low)	2	3	4	5 (Medium)	6	7	8	9	10 (High)

The effect of an arch's self-weight on how it handles loads.

1 (Low)	2	3	4	5 (Medium)	6	7	8	9	10 (High)

The importance of horizontal forces in supporting arches.

1 (Low)	2	3	4	5 (Medium)	6	7	8	9	10 (High)

Suspension Bridges

How a suspension bridge works.

1 (Low)	2	3	4	5 (Medium)	6	7	8	9	10 (High)

The relationship between the main cable's shape and the horizontal forces.

1 (Low)	2	3	4	5 (Medium)	6	7	8	9	10 (High)

How large horizontal forces on the towers can be reisisted.

1 (Low)	2	3	4	5 (Medium)	6	7	8	9	10 (High)

How large horizontal forces on the towers can be reisisted.

1 (Low)	2	3	4	5 (Medium)	6	7	8	9	10 (High)

The importance of deck stiffness.

1 (Low)	2	3	4	5 (Medium)	6	7	8	9	10 (High)

Gothic Cathedrals

The forces that vaulted ceilings produce on their supporting structures.

1 (Low)	2	3	4	5 (Medium)	6	7	8	9	10 (High)

The purpose of flying buttresses and how they work.

1 (Low)	2	3	4	5 (Medium)	6	7	8	9	10 (High)

The importance of assembly sequencing in building construction.

1 (Low)	2	3	4	5 (Medium)	6	7	8	9	10 (High)

Soil and Water Pressure Part 1: Concepts

How pressure forces arise in fluids and granular material.

1	2	3	4	5	6	7	8	9	10
(Low)				(Medium)					(High)

How pressures vary with depth.

1	2	3	4	5	6	7	8	9	10
(Low)				(Medium)					(High)

Factors that affect pressure.

1	2	3	4	5	6	7	8	9	10
(Low)				(Medium)					(High)

Soil and Water Pressure Part 2: Dams

How dams work.

1	2	3	4	5	6	7	8	9	10
(Low)				(Medium)					(High)

The importance of dam shape.

1	2	3	4	5	6	7	8	9	10
(Low)				(Medium)					(High)

Soil and Water Pressure Part 3: Retaining Walls

The ways in which retaining walls can fail.

1	2	3	4	5	6	7	8	9	10
(Low)				(Medium)					(High)

The optimal orientation of L-shaped walls.

1	2	3	4	5	6	7	8	9	10
(Low)				(Medium)					(High)

Soil and Water Pressure Part 4: Silos and Tanks

The loads vertical cylinder tanks must carry.

1	2	3	4	5	6	7	8	9	10
(Low)				(Medium)					(High)

The most efficient distribution for reinforcements along a silo.

1	2	3	4	5	6	7	8	9	10
(Low)				(Medium)					(High)

Soil and Water Pressure Part 5: Tunnels and Culverts

The pros and cons of circular tunnels.

1 (Low)	2	3	4	5 (Medium)	6	7	8	9	10 (High)

The pros and cons of rectangular tunnels.

1 (Low)	2	3	4	5 (Medium)	6	7	8	9	10 (High)

The importance of proper backfilling.

1 (Low)	2	3	4	5 (Medium)	6	7	8	9	10 (High)

Please indicate your opinion on the question below.

Will you watch these videos again in the future?

Definitely not	Probably not	Unsure	Probably	Definitely