# AC 2011-1564: WHAT DO STUDENTS GET OUT OF SOLID MODELING VIDEO DEMONSTRATIONS?

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# What Do Students Get Out of Solid Modeling Video Demonstrations?

Abstract

This is a continuing examination of moving an introductory engineering graphics course from face-to-face to a hybrid or blended format. In this study the researchers took a first look at how students used the online resources related to solid modeling instruction. Online video demonstrations were placed within a learning management system (LMS) so that faculty could more accurately determine how students were using the resources. Selected student modeling exercises were evaluated for near and far learning transfer of concepts for two sections of the course. For early assignments during the semester, there does not appear to be a difference in model correctness between students who watched the video demonstrations and those who did not. The number of desired modeling concepts present in final projects was higher for students who watched more of the videos during the semester.

## Introduction

Foundations of Engineering Graphics, GC 120, is an introductory engineering graphics course at North Carolina State University. A majority of the students enrolled in the course are completing their second year of coursework in engineering. The course consists of a hybrid format containing online instruction through video lectures and demonstrations coupled with face-to-face class time with an instructor. The course utilizes the Moodle learning management system to organize and distribute course resources to the students. Previous studies involving this course suggest that students had multiple strategies for making use of the online resources related to asynchronous video lectures, and that these strategies had implications for learning outcomes on summative measures in the course [1-5].

The researchers are studying the efficiency of knowledge transfer between concepts presented within the online solid modeling demonstrations and submitted student work. For this research, data was collected from students who were enrolled in two sections of the course taught by the same instructor. Data were collected and analyzed to better understand when students viewed the software demonstrations in relation to when they submitted assignments. The analysis involved assessing student work based upon rubrics which state implicit and explicit concepts presented within the video lectures. Student work was selected in a manner that assessed near transfer of knowledge and concepts (i.e., simply following the video verbatim) along with far transfer of concepts where students do similar work without the assistance of step-by-step instruction from the video demonstrations supporting solid modeling.

For this study, two definitions related to transfer of learning are important. ***Near transfer*** of knowledge occurs when the activity or learning situation closely resembles the original activity or situation. ***Far transfer*** occurs when a student's knowledge is applied to an activity or situation that varies from the initial activity [6]. In the hybrid GC 120 course, students were asked to complete two assignments in each of the weekly units. The first assignment was to replicate what was presented in the video demonstration for the unit (near transfer). For the second assignment, students were asked to complete an activity that was similar to the first assignment but with no help from a tutorial (far transfer). Also analyzed in this study were final projects, which gave researchers another chance to evaluate the far transfer of concepts in a summative fashion.

## Solid Modeling Concepts

Constraint-based solid modeling has been an integral part of GC 120 since the spring 2001 semester. Faculty have continued to make improvements to the solid modeling tutorials over the last 9 years, which initially consisted of printed handouts. In 2002 handouts were replaced with web pages with screen captures of key steps in the assignment. Streaming video demonstrations replaced these static web pages in 2007. As part of a parallel evaluation activity, faculty have been identifying key concepts that need to be covered in the course based on textbook concepts and industry practice and creating a formal inventory of how these concepts map to course instructional resources.

It is possible that some might consider these skills rather than concepts. The researchers consider these concepts since they are independent of a particular CAD system and require the learner to strategically apply the knowledge using a higher-level understanding of constraint-based modeling. In the analysis the researchers separated the items specific to SolidWorks™ from those more general concepts.

To begin this process, the researchers examined the 18 videos that directly support instruction in the course. An inventory of the concepts was completed, which included explicit concepts that were explained and demonstrated as well as implicit concepts that were just performed. After an initial list was compiled and refined by the researchers, eighty concepts were identified and categorized. Table 1 displays the concept categories and frequencies per concept category.

Table 1. Concepts Covered in the Solid Modeling Videos.

| Concepts Addressed in the Solid Modeling Videos | Number of Concepts Per Concept Category |
|---|---:|
| SolidWorks™ Specific Concepts | 4 |
| Modeling General Concepts | 3 |
| Sketch | 15 |
| Relations | 10 |
| Features | 11 |
| Dimensions | 16 |
| Assembly | 4 |
| Mates | 5 |
| Drawing | 9 |
| View | 3 |
| **TOTAL** | **80** |

In addition to the concepts covered in the demonstration videos, an analysis was made of the concepts covered in the required textbook for the course [7]. The textbook concepts were then compared to the concepts covered in the videos. As one would expect, the textbook concepts tend to be general enough to apply to any constraint-based computer-aided design program. Although some of the concepts covered in the online video demonstrations are general enough to apply to other programs, most are specific to SolidWorks™.

## Methodology

For this research, data were collected from two sections of GC 120 taught by one instructor during the Fall 2010 semester. All online materials for the course were available only through Moodle™. Tables 2-4 display the enrollment and demographic data for the participants.

Table 2. Enrollment Per Hybrid Section of GC 120.

| Section | Frequency | Percent |
|---|---|---|
| 001 | 30 | 52% |
| 005 | 28 | 48% |
| TOTAL | 58 | 100% |

Table 3. Academic Year.

| Year | Frequency | Percent |
|---|---|---|
| Freshmen | 7 | 12% |
| Sophomore | 35 | 60% |
| Junior | 8 | 14% |
| Senior | 8 | 14% |
| TOTAL | 58 | 100% |

Table 4. Academic Major.

| Major | Frequency | Percent |
|---|---|---|
| Agriculture & Life Sciences | 5 | 8% |
| Civil Engineering / Construction Management | 8 | 14% |
| Computer Science | 4 | 7% |
| Mechanical Engineering | 18 | 31% |
| Other Engineering Majors | 15 | 26% |
| Education | 4 | 7% |
| Other Majors | 4 | 7% |
| TOTAL | 58 | 100% |

There were 58 students initially enrolled in the two hybrid sections of the course. A majority of these students were sophomores (60%) since GC 120 falls in the sophomore year of many engineering majors. Seventy-one percent of the students were enrolled in engineering majors with the largest percentages coming from mechanical and civil engineering.

As in previous semesters, students were required to view and complete online materials each week. These materials were organized into 12 weekly online units. Each unit consisted of streaming media presentations of the textbook material, streaming media SolidWorks™ demonstrations, and streaming media sketching demonstrations. Students also were required to complete a 10-20 question online quiz in Units 1-5 and 8-11 as an assessment of their textbook knowledge. Each assessment was paired with a streaming video of a voiced-over PowerPoint™ presentation of the key concepts of the required textbook readings for the week. Each unit also had at least one SolidWorks™ video demonstration. Students were typically asked to complete the activity demonstrated in the video as well as another activity that was similar. Of interest in this study was how students performed on both of these assignments with the purpose of examining near and far transfer of the concept learning.

Since all of these materials were placed within Moodle™, the researchers could track how students progressed through the materials. Of particular interest in this study was how students made use of the online materials related to the solid modeling demonstrations. Students were given access to 18 solid modeling video demonstrations in the units. Table 5 shows the number of videos watched by students in the two sections.

Table 5. Number of Solid Modeling Videos Watched.

| Videos Watched | Frequency | Percent |
|---|---|---|
| 18 | 3 | 5% |
| 17 | 7 | 13% |
| 16 | 4 | 7% |
| 15 | 3 | 5 % |
| 14 | 9 | 16% |
| 13 | 7 | 13% |
| 12 | 9 | 16% |
| 11 | 7 | 13% |
| 10 | 2 | 4% |
| 9 | 4 | 7% |
| 8 | 1 | 2% |
| TOTAL | 56 | 100% |

For this preliminary evaluation of the solid modeling concepts, one near transfer and three far transfer activities were selected. The near transfer activity was the ROD GUIDE (Figure 2), and its paired far transfer activity was the EYELET (Figure 3). The second far transfer activity was the TAPER COLLAR (Figure 4). This activity was given in Unit 10 and consisted of a solid model and a drawing. The final transfer activity was the final project that students completed as the culmination of their experience in the class. For this final project students were to reverse engineer a LEGO™ kit of their choosing as long as it consisted of around 15 unique parts.

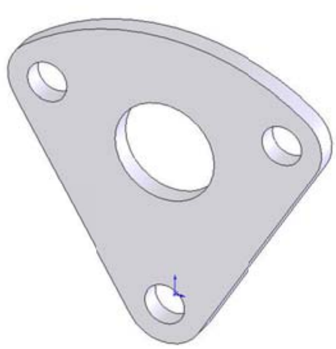

Figure 2. The ROD GUIDE model.

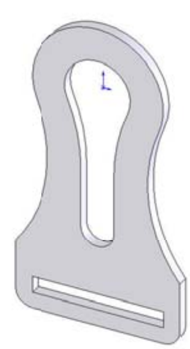

Figure 3. The EYELET model.

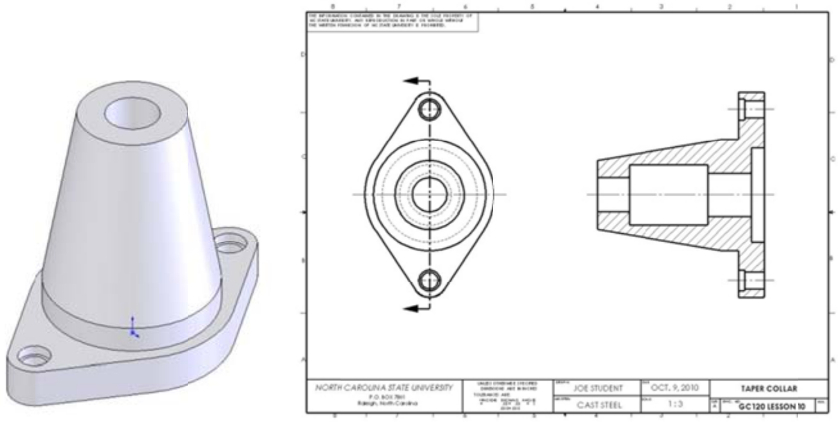


Figure 4. The TAPER COLLAR Model and Drawing.

## Results

Concepts for each assignment were reviewed to determine which could be easily identified and measured within each student's solid modeling file. There were 13 measureable concepts identified for the ROD GUIDE model, 19 for the EYELET model, 21 for the TAPER COLLAR model and drawing, and 25 for the FINAL PROJECT. Once the concepts were outlined, all four activities for each student were assessed for the presence of each identified concept. Tables 6-9 show the results for the four assignments.

Table 6. Analysis of ROD GUIDE Assignment.

| | Frequency | Percent | Mean # of Concepts |
|---|---|---|---|
| Watched RG Video | 36 | 67% | 11.47 |
| Did Not Watch | 18 | 33% | 10.50 |
| TOTAL | 54 | 100% | |

Table 7. Analysis of EYELET Assignment.

| | Frequency | Percent | Mean # of Concepts |
|---|---|---|---|
| Watched RG Video | 36 | 67% | 18.00 |
| Did Not Watch | 18 | 33% | 17.90 |
| TOTAL | 54 | 100% | |

Table 8. Analysis of TAPER COLLAR Assignment.

| Videos Watched Prior to Assignment | Frequency | Percent | Mean # of Concepts |
|---|---|---|---|
| 12-13 | 15 | 29% | 14.20 |
| 10-11 | 21 | 42% | 15.00 |
| 6-9 | 15 | 29% | 14.30 |
| TOTAL | 51 | 100% | |

Table 9. Analysis of FINAL PROJECT Assignment.

| Videos Watched Prior to Assignment | Frequency | Percent | Mean # of Concepts |
|---|---|---|---|
| 15-18 | 16 | 36% | 19.63 |
| 12-14 | 19 | 42% | 19.16 |
| 8-11 | 10 | 22% | 18.00 |
| TOTAL | 45 | 100% | |

For the near transfer ROD GUIDE solid modeling activity, 36 students watched the video before or as they were modeling the part. The mean number of concepts present for these students was 11.47 out of the 13 measureable concepts identified for the assignment. The mean number of concepts present for students who did not watch the video was 10.50. The EYELET was the far transfer activity for the ROD GUIDE video. For students who watched the ROD GUIDE video, the mean number of concepts present in their files was 18.00 out of the 19 measureable concepts. The mean for students who did not watch the video was 17.90. The next assignment evaluated was the TAPER COLLAR. As shown in Figure 4, this consisted of a solid model and a drawing. There were 21 measureable concepts identified for this assignment. Leading up to this activity, students had the opportunity to view 13 videos related to the creation of solid models and drawings. As shown in Table 8, students who watched 12 or 13 of the videos had 14.20 out of 21 concepts present in their files. The mean for students who watched 10 or 11 of the videos was 15.00. The mean for students who watched between 6 and 9 of the videos was 14.30. For the FINAL PROJECT assignment there were 25 identifiable concepts to evaluate. Students had the opportunity to watch all 18 video demonstrations leading up to this assignment. Table 9 shows that students who between 15 and 18 of the videos had 19.63 out of 25 concepts present in their submitted assignment. The mean for students who watched between 12 and 14 videos was 19.16. The mean for students who watched between 8 and 11 videos was 18.00.

## Discussion and Conclusions

Data was collected and analyzed to better understand if viewing the online software demonstrations improved students' performance on modeling activities. The analysis involved assessing student work based upon measureable concepts presented in the video demonstrations. Student work was selected in a manner that assessed near transfer of knowledge and concepts (i.e., simply following the video verbatim) along with farther transfers of concepts where students did similar work without the assistance of step-by-step instruction from the video demonstrations supporting solid modeling.

Similar to previous studies of this course where students' use of video lectures were examined[2-5], not all students took advantage of the online materials. For the first two assignments there does not appear any difference between students who watched the videos and those who did not watch the videos. In the final project assignment there seems to be an increase in the number of concepts present as the students watch more of the video demonstrations. This could be explained by several things. First, the instructor did demonstrate and reinforce concepts in the face-to-face sessions of the class, so it is possible that students who did not watch the online videos felt that the explanations given by the course instructor in class were sufficient. Another possible explanation could be that students who did not watch the videos had prior experience in high school with the software. SolidWorks™ is used in about half of the high school drafting programs in North Carolina. A third explanation could be that the explicit objectives introduced in each video were not an exhaustive list of all the concepts present. Pre-instructional objectives consisted of the main ideas that would be presented in the video and were kept to a relatively short list. Students may not have perceived the importance of incorporating previous concepts (far transfer) into their work.

## Future Work

Considering that the researchers only looked at one assignment from the beginning of the semester, one assignment near the end, and the final project, more research will be conducted analyzing the implementation of these concepts throughout the semester and within more student work. Research can include looking at a specific unit of instruction to better understand concept transference from the videos into student work within assignments that are less spread out across the semester. This will provide a stronger basis for understanding what concepts students are able to transfer to a unique environment where no step-by-step videos are given.

## References


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