OFFICE OF
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Improving Learning Through Assessment

Brief Evaluation Report on Pilot of Dr. Frame Software CalPoly Implementation

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BACKGROUND

This report summarizes an evaluation of a pilot version of an innovative course software package, called "Dr. Frame." Used in engineering classes, the software is designed to provide hands-on experience to students with the characteristics of certain structures. In Spring of 2006, two implementations of the software were used in an engineering class at California Polytechnic State University in San Louis Obispo as part of in-class activities. As part of these exercises, students completed a pre-survey and post-survey for each of the two activities: Frame & Stiffness. For both the Frame and Stiffness activities, pre- and post-surveys contained content questions (parallel questions for pre- and post-) aimed at assessing changes in students' understanding relevant concepts. The post-survey contained a set of evaluative questions to assess students' satisfaction with the software and the extent to which they found it useful.

The surveys were presented as online questionnaires at the beginning and the end of each exercise. Within the assignment, an introduction to the evaluation project was presented along with a link to the survey itself. Students' participation was voluntary, although the activities were done as part of in-class activities. For the frame activity, a total of 23 students completed a pre-survey and 20 completed a post-survey. For the stiffness activity there were 16 completed pre-surveys and 15 completed post-surveys.

RESULTS

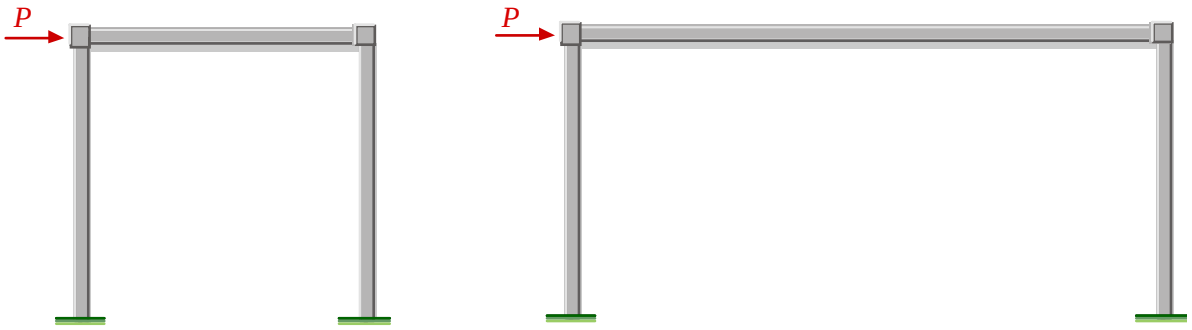
The descriptive results presented below are separated first according to activity (Frame or Stiffness). Within each activity, the pre- and post-comparisons of the content-related questions are presented first, followed by an analysis of the evaluative items presented only on the post-survey.

Frame Activity

Frame Pre-Post Comparisons: Conceptual Questions

There were three conceptual questions presented on both the pre- and post-surveys:

The two frames shown below are identical except for the bay width:



A B

1. Which frame will have larger base moments at the supports?

   (a) Frame A
   (b) Frame B
   (c) They will be equal

2. Which frame will have a larger horizontal displacement at the loaded joint?

   (a) Frame A
   (b) Frame B
   (c) They will be equal

3. What would be the most effective way to reduce the horizontal displacement of frame A?

(a) Increase the moment of inertia of the columns by a factor of 2.
(b) Increase the moment of inertia of the cross beam by a factor of 2.
(c) Reduce the moment of inertia of the cross beam by a factor of 2.
(d) Reduce the moment of inertia of the columns by a factor of 2.

Figures 1 through 3 show the percentage of respondents provided each answer for the pre- and post- conceptual survey questions, presented below:

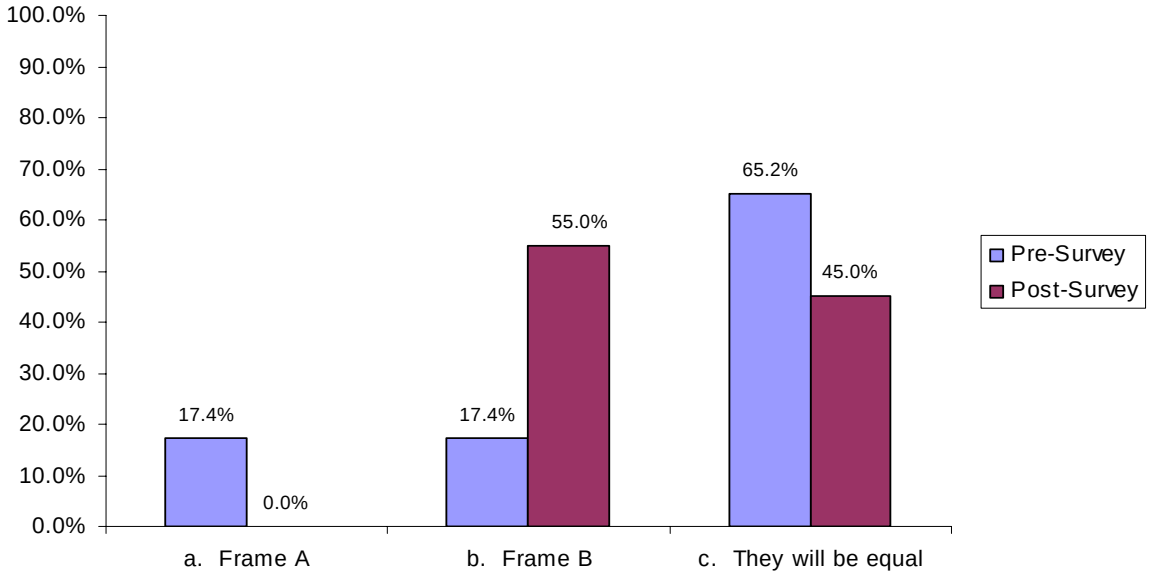


Figure 1. Percentage of individuals providing each response to Question 1 on the pre- and post-survey for the FRAME activity.

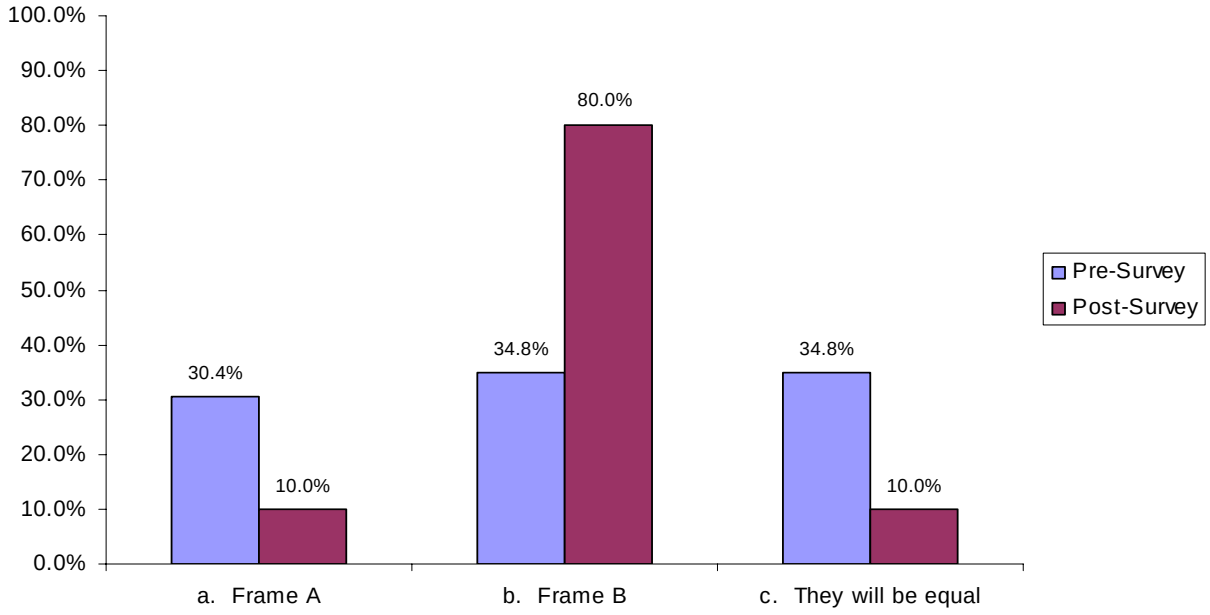


Figure 2. Percentage of individuals providing each response to Question 2 on the pre- and post-survey for the FRAME activity.

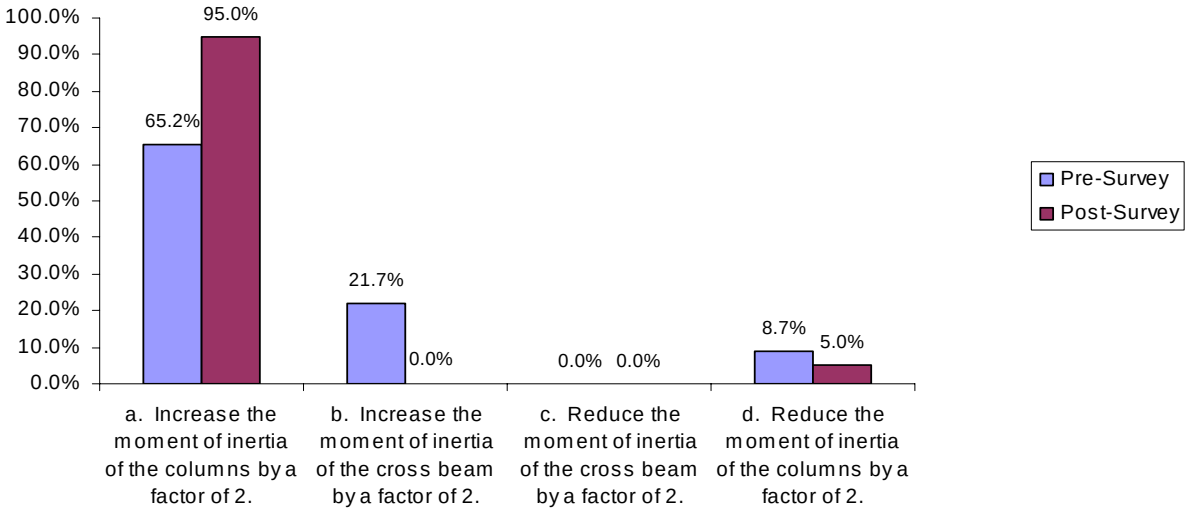


Figure 3. Percentage of individuals providing each response to Question 3 on the pre- and post-survey for the FRAME activity.

Participants were also asked to rate their level of confidence in the responses they provided on the conceptual questions on both the pre-survey and post-survey, from a scale of 1 "Not at all confident" to 6 "Completely confident." Mean confidence ratings for each question, both pre- and post- are presented in Figure 4.

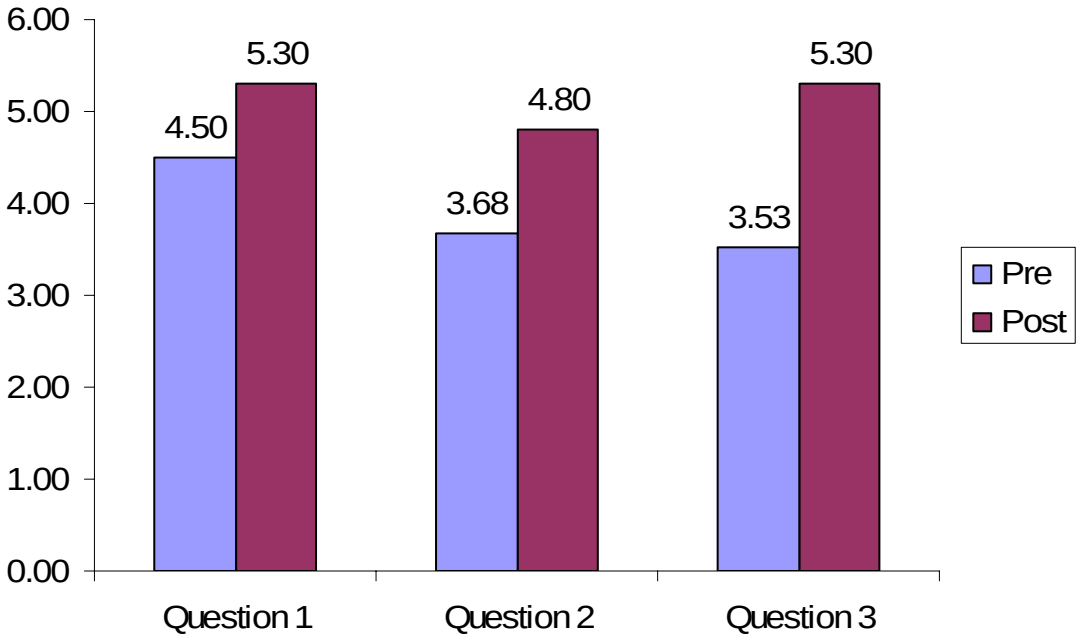


Figure 4. Mean confidence ratings (on a scale of 1: Not at all confident to 6: Completely confident) provided by participants about their responses to three conceptual questions on the pre- and post-surveys for the FRAME activity.

Frame Post-Survey: Evaluative Questions

Ratings

The evaluative questions on the post-survey began with a set of six statements; participants were asked to indicate the extent to which they agreed or disagreed with the statements. Table 1 shows the frequency, mean and standard deviation of their responses.

Table 1: Descriptive statistics for six evaluative statements of the FRAME activity.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	*Mean*	SD
	1	*2*	*3*	*4*	*5*		
This activity enhanced my understanding the behavior of frames.	0.0%	0.0%	5.0%	60.0%	35.0%	4.30	0.57
The software was easy to use.	0.0%	0.0%	10.0%	60.0%	30.0%	4.20	0.62
I enjoyed this activity.	0.0%	0.0%	15.0%	60.0%	25.0%	4.10	0.64
This activity was a good use of my time.	0.0%	0.0%	10.0%	55.0%	30.0%	4.21	0.63
Now that I've completed this assignment, I will probably have to study less for the final exam.	20.0%	35.0%	25.0%	15.0%	5.0%	2.50	1.15
If given the opportunity, I would like to return to this activity as a study resource.	0.0%	5.0%	10.0%	60.0%	25.0%	4.05	0.76

As a visual presentation of these data, Figure 5 shows the mean ratings for each item.

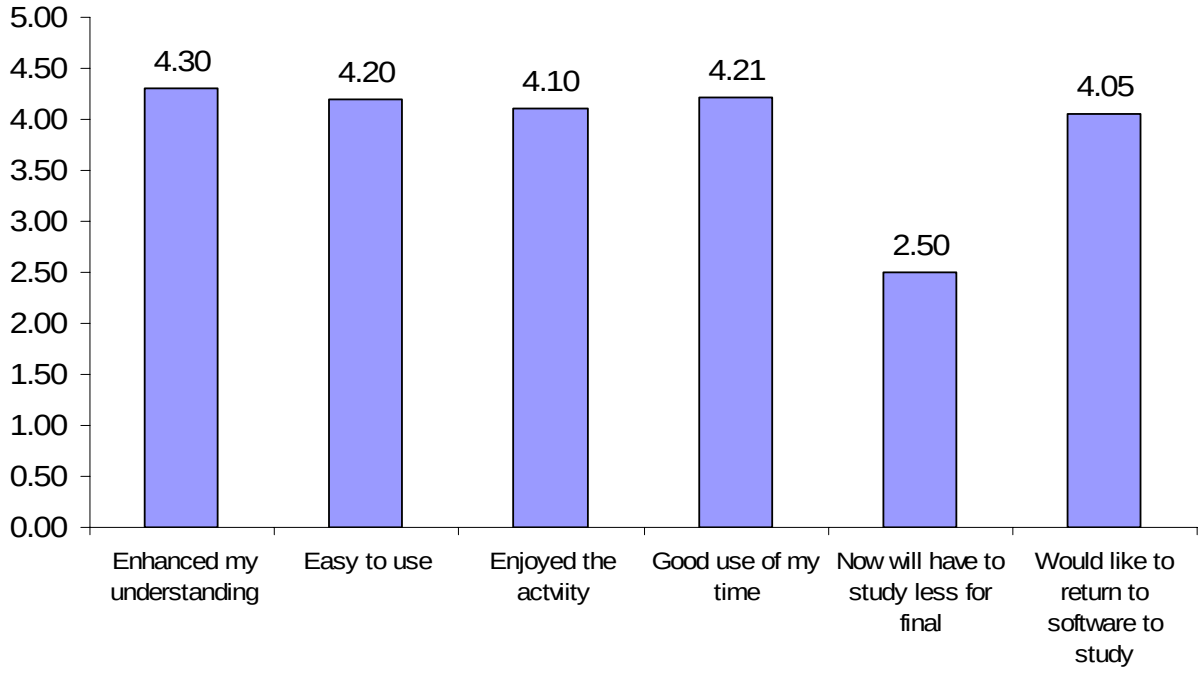


Figure 5. Mean ratings for each of the rated evaluation items on the post-survey for the FRAME activity .

Open-Ended Responses

Below is a complete list of all responses from students to each of the four open-ended evaluative questions at the end of the survey.

What, if anything, did you find particularly valuable about this activity?

- Showing different situations
- To be able to see the actual physical changes in the beam deflection as well as the moment diagram as soon as changes were made.
- I enjoyed that one could place andy member and length and see the results quickly. It felt more hands on.
- It was nice to see real time answers and reactoins without having to crunch a lot of numbers and visulize what they mean.
- The visual representations of displacements and moments were very useful.
- The explanations provided for that certain topic and the tools were easy to get used to.
- Getting quick results to problems
- Being able to instantly see the effects that minor adjustments had on frames was a great way to improve the learning curve.
- Having answers available in seconds.

- You can work out problems and check yourself to see if you are right. It is just a good tool to have when doing simple structures.
- seeing displacements and moment diagrams
- EXCELLENT visual representation of what we are trying to comprehend as structural analysis students. To be able to apply whatever load we want to any structure we design within reason, visualize shear & moment diagrams at the same time... it is extremely useful to conceptually understand what the structures look like with different load changes. Very impressed with other features as well that I don't know how to use that well, but especially the x-ray glasses and plotting options. Nice to be able to visually see interlinking models of the same structure change while the mouse is dragging.
- it give me answers
- I like the immediate feedback
- The activity is very visual. Most assignments can be confusing and hard to relate to. This activity makes understanding structures very clear.

Did you have any technical problems with the software? If so, please describe these in detail below

- No problems (7 responses)
- Deleting the Members. I think there should be a right-click option to delete the members.
- The technical problems I had happened when trying to add a force to a member, the program had a hard time picking up where the member was. It took about 3 minutes for it to finally attach a force. The same issue happend with labeling the moment.
- Through this short test, I wasn't able to explore much into the software, but it does seem user friendly.
- Very Slow
- It crashed once during the example, but I had clicked back and forward across a particular atep, so that's probably what caused it.
- Software related terms were not obvious. Some kind of highlight would help a lot (when reffering to certain pane or button)
- tHE PROGRAM CRASHED 3-4 TIMES ON ME while i was adjusting and navigating backwards and forewards through the demo. It also crashed when i created a new file and started framing myself.
- I could not copy and paste the frame
- Either the computer or the program kept getting screwed up and it would shut the program down (four times).

How, if at all, do you think this activity could have been improved?

- Have more user interaction, such as having the user manually change some of the forces (maybe towards the end of the activity)
- Maybe using head phones with an automative voice...just an idea
- Speed up
- Answering the questions that were provided for critical thinking
- No
- Highlighting exactly where each number is located in the program. Its slightly confusing (at first) to find where displacement values or displayed (as well as others).
- I think this activity was a great intro... I also think it would be valuable to teach an intro class using this software so that engineers can visually understand with confidence what happens to the beams as they apply loads and moments.
- Shorter
- Maybe making the instructions less wordy. I would add more lists and less paragraphs

Any additional comments about the activities?

- No
- I thought it was very useful!
- It was fun to learn!
- Cool program. I'll definately be using it to check my work.
- This software would be an amazing asset to students and design proffesionals alike. A five week summer class would be a great experimental test to this class. I would take it if I knew what it offered me!
- I like this software because I am free to experiment with the parameters of a structure and get the "answers" to verify my own analysis.
- This is very useful and it is much more enjoyable then crunching numbers out to see the effect of a load on a frame/structure.
- Overall very helpful and easy to use

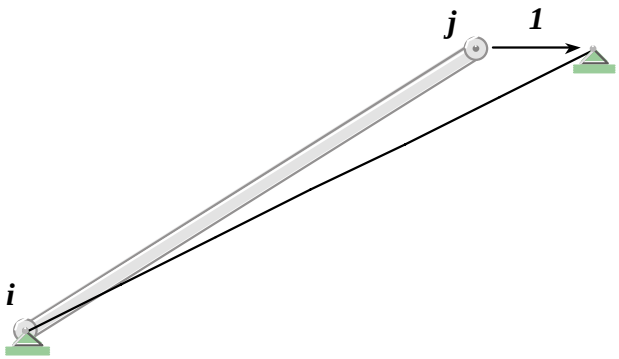
Stiffness Activity

Stiffness Pre-Post Comparisons: Conceptual Questions

There were three conceptual questions presented on both the pre- and post-surveys:

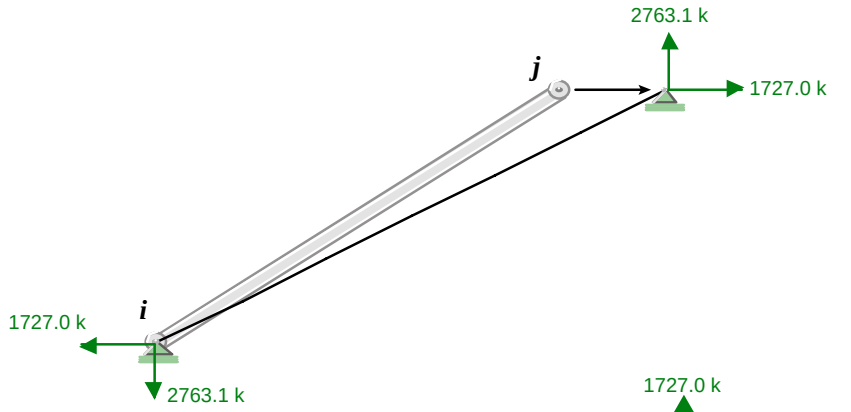
1. A truss element is subjected to a unit displacement in the horizontal direction at joint *j* as shown below. The global stiffness matrix for this element is given by:

$$K = \begin{bmatrix} 2763.1 & 1727.0 & -2763.1 & -1727.0 \\ 1727.0 & 2763.1 & -1727.0 & -2763.1 \\ -2763.1 & -1727.0 & 2763.1 & 1727.0 \\ -1727.0 & -2763.1 & 1727.0 & 2763.1 \end{bmatrix} \text{ k/in}$$

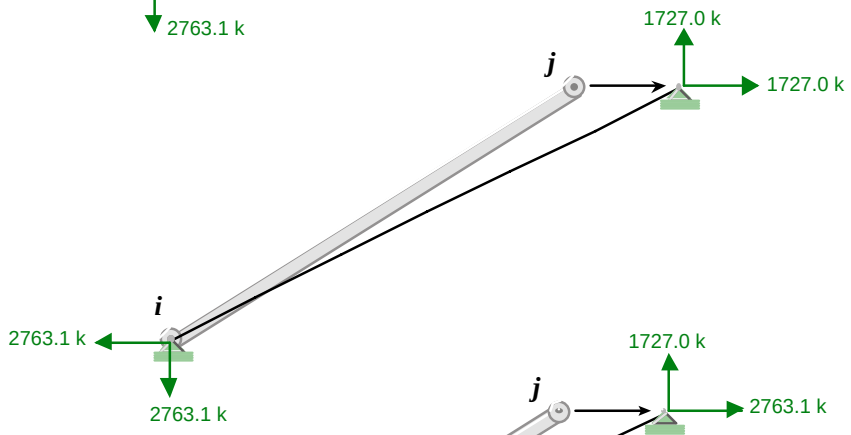


Identify the correct set of reaction forces:

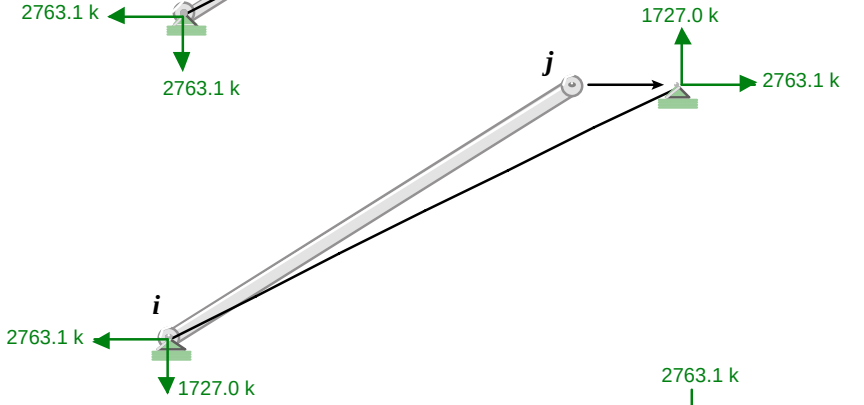
(a)


2763.1 k
j
1727.0 k
i
1727.0 k
2763.1 k

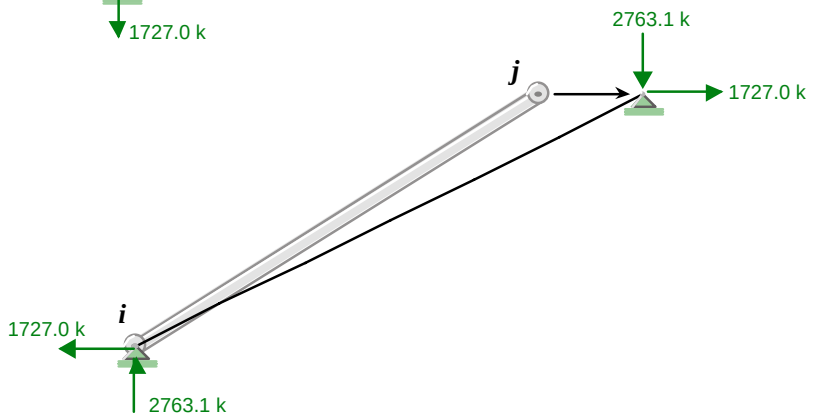
(b)


1727.0 k
j
1727.0 k
i
2763.1 k
2763.1 k

(c)

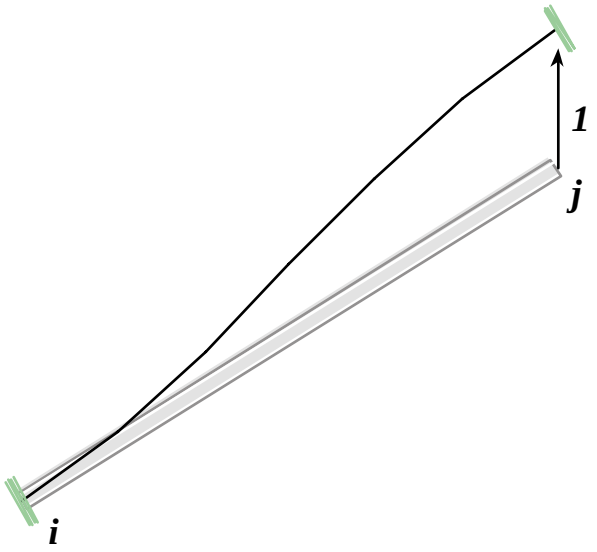

1727.0 k
j
2763.1 k
i
2763.1 k
1727.0 k

(d)


2763.1 k
j
1727.0 k
i
1727.0 k
2763.1 k

2. A frame element is subjected to a vertical displacement at end *j* with all rotations fixed, as indicated. The stiffness matrix for this element is given below:

$$K = \begin{bmatrix} 2772 & 1712 & -163.1 & -2772 & -1712 & -163.1 \\ 1712 & 1103 & 261.0 & -1712 & -1103 & 261.0 \\ -163.1 & 261 & 3870 & 163.1 & -261 & 1935 \\ -2772 & -1712 & 163.1 & 2772 & 1712 & 163.1 \\ -1712 & -1103 & -261.0 & 1712 & 1103 & -261.0 \\ -163.1 & 261.0 & 1935 & 163.1 & -261.0 & 3870 \end{bmatrix}$$



What is the moment at end *j* (assuming consistent units)?

(a) 163.1
(b) 1103
(c) -163.1
(d) -261.0

Figures 6 and 7 show the percentage of respondents provided each answer for the pre- and post- conceptual survey questions, presented below:

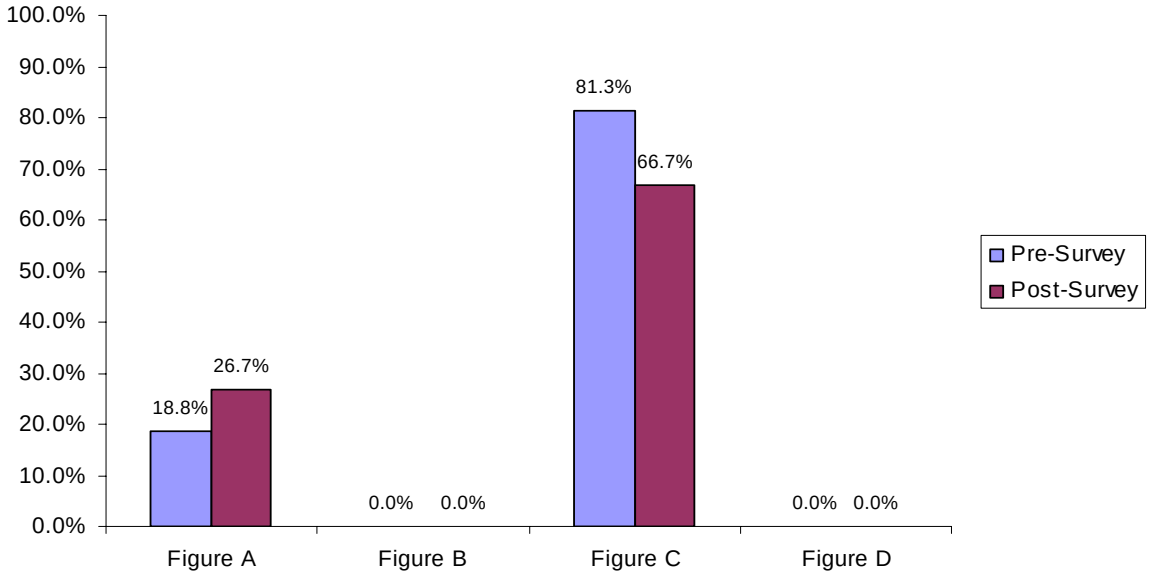


Figure 6. Percentage of individuals providing each response to Question 1 on the pre- and post-survey for the STIFFNESS activity.

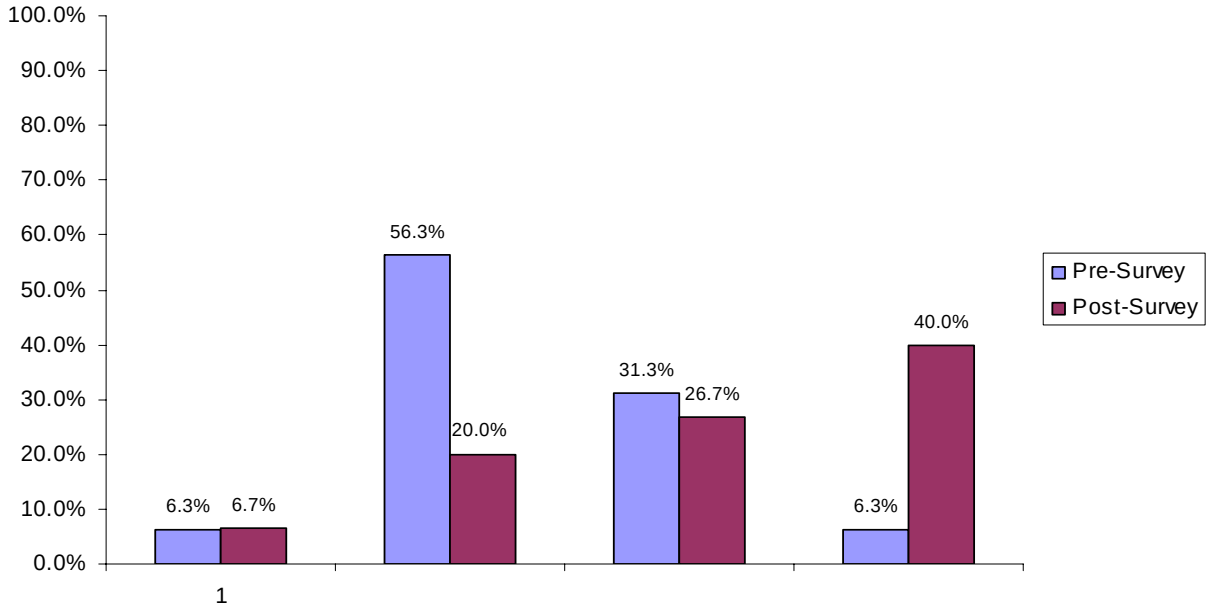


Figure 7. Percentage of individuals providing each response to Question 2 on the pre- and post-survey for the STIFFNESS activity.

Participants were also asked to rate their level of confidence in the responses they provided on the conceptual questions on both the pre-survey and post-survey, from a scale of 1 "Not at all confident" to 6 "Completely confident." Mean confidence ratings for each question, both pre- and post- are presented in Figure 8.

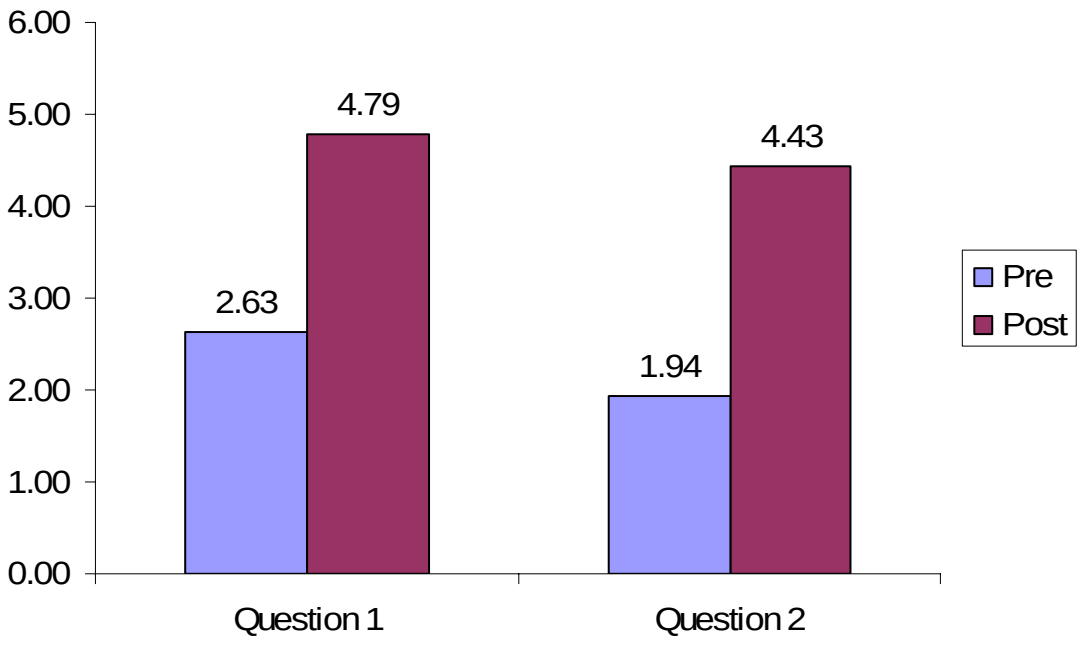


Figure 8. Mean confidence ratings (on a scale of 1: Not at all confident to 6: Completely confident) provided by participants about their responses to three conceptual questions on the pre- and post-surveys.

Stiffness Post-Survey: Evaluative Questions

Ratings

The evaluative questions on the post-survey began with a set of six statements; participants were asked to indicate the extent to which they agreed or disagreed with the statements. Table 2 shows the frequency, mean and standard deviation of their responses.

Table 2: Descriptive statistics for six evaluative statements of the STIFFNESS activity.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	*Mean*	SD
	1	*2*	*3*	*4*	*5*		
This activity enhanced my understanding of stiffness.	6.7%	13.3%	20.0%	26.7%	33.3%	4.15	0.69
The software was easy to use.	0.0%	0.0%	20.0%	33.3%	26.7%	4.08	0.79
I enjoyed this activity.	0.0%	0.0%	33.3%	26.7%	26.7%	3.92	0.86
This activity was a good use of my time.	0.0%	0.0%	20.0%	40.0%	26.7%	4.08	0.76
Now that I've completed this assignment, I will probably have to	13.3%	20.0%	40.0%	13.3%	0.0%	2.62	0.96

study less for the final exam.							
If given the opportunity, I would like to return to this activity as a study resource.	0.0%	0.0%	20.0%	46.7%	20.0%	4.00	0.71

As a visual presentation of these data, Figure 9 shows the mean ratings for each item.

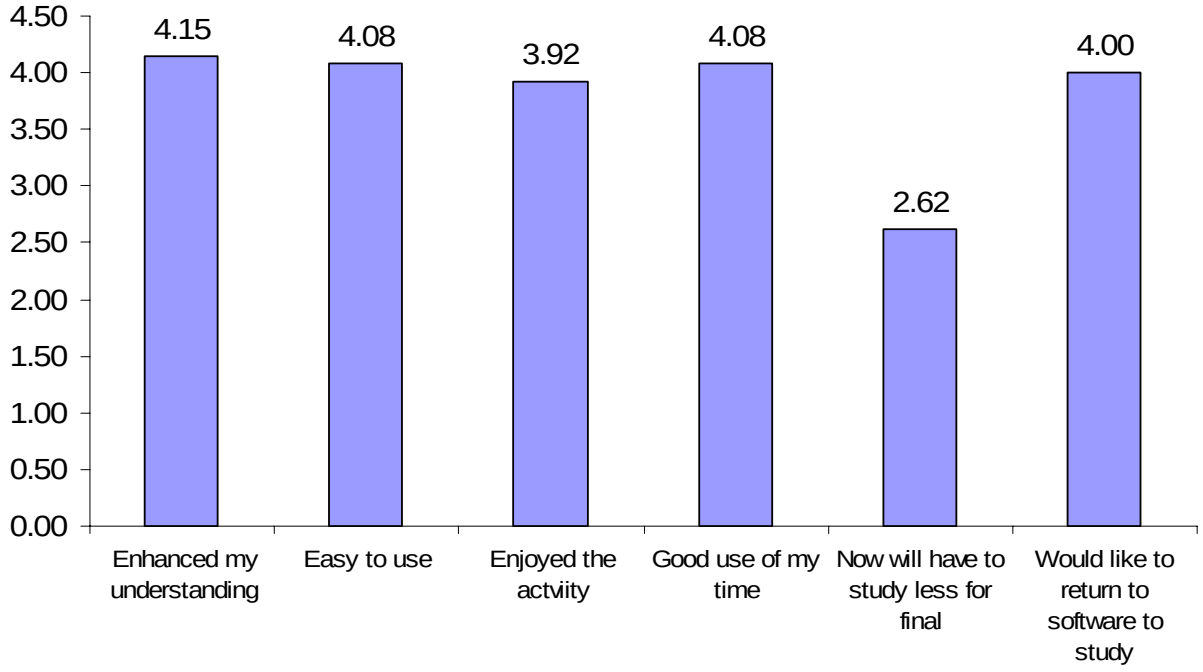


Figure 9. Mean ratings for each of the rated evaluation items on the post-survey for the STIFFNES activity.

Open-Ended Responses

Below is a complete list of all responses from students to each of the four open-ended evaluative questions at the end of the survey.

<u>What, if anything, did you find particularly valuable about this activity?</u>

- the ability to quickly see the deformations with different loading conditions
- Being able to move and change the displacements mannually and seeing what it does to the resulting forces.
- I was pretty rusty on this material, but now I feel as though I have a much stronger grasp on it. I will definately use it as a education tool.
- It made stiffness matracies much more understandble, because I couls see easily where the components of the matrix were coming from.

- The repetition was a very good way to understand the relationships between the stiffness and the reactions.
- The immediate response to new situations

Did you have any technical problems with the software? If so, please describe these in detail below

- None/no technical problems (5)

How, if at all, do you think this activity could have been improved?

- require the student to apply the tactics that were shown in the demo (so that the student has to interact with the software)
- A key to note the ordering of the degrees of freedom would have been helpful on the pre-test
- Highlight matrix values that correspond to the force values on the demo

Any additional comments about the activities?

- very helpful, thanks
- I enjoyed this more so than the other information...probably because I am more rusty on this material.