

Integrating WeBWork, CalcPlot3D, and Flipgrid in a mostly asynchronous online multivariable calculus class

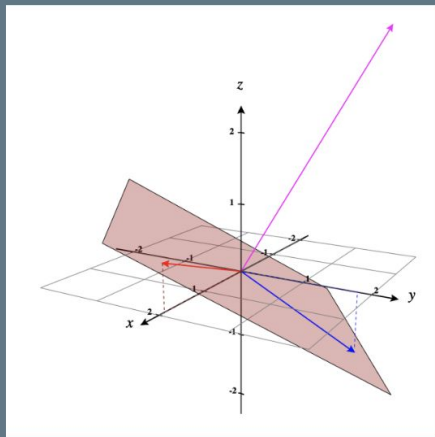
Monica VanDieren, PhD
Robert Morris University



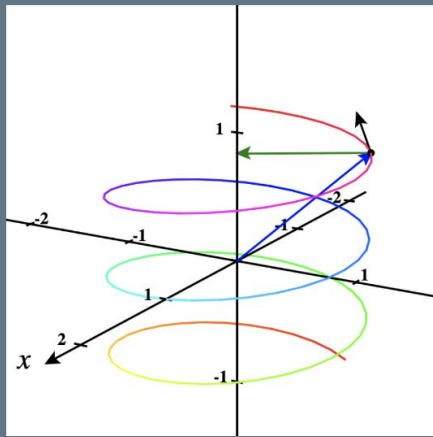
Context



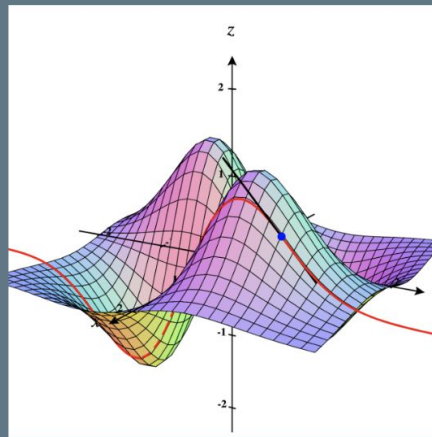
- Professionally-focused, regional, suburban university
- 4000 undergraduates
- Multivariable Calculus courses ranging from 10-25 students



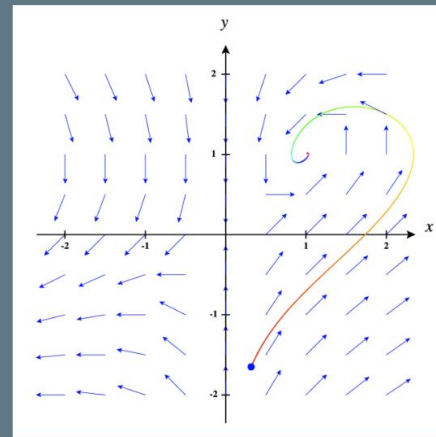
Foundations: Vectors, Planes,
and Lines



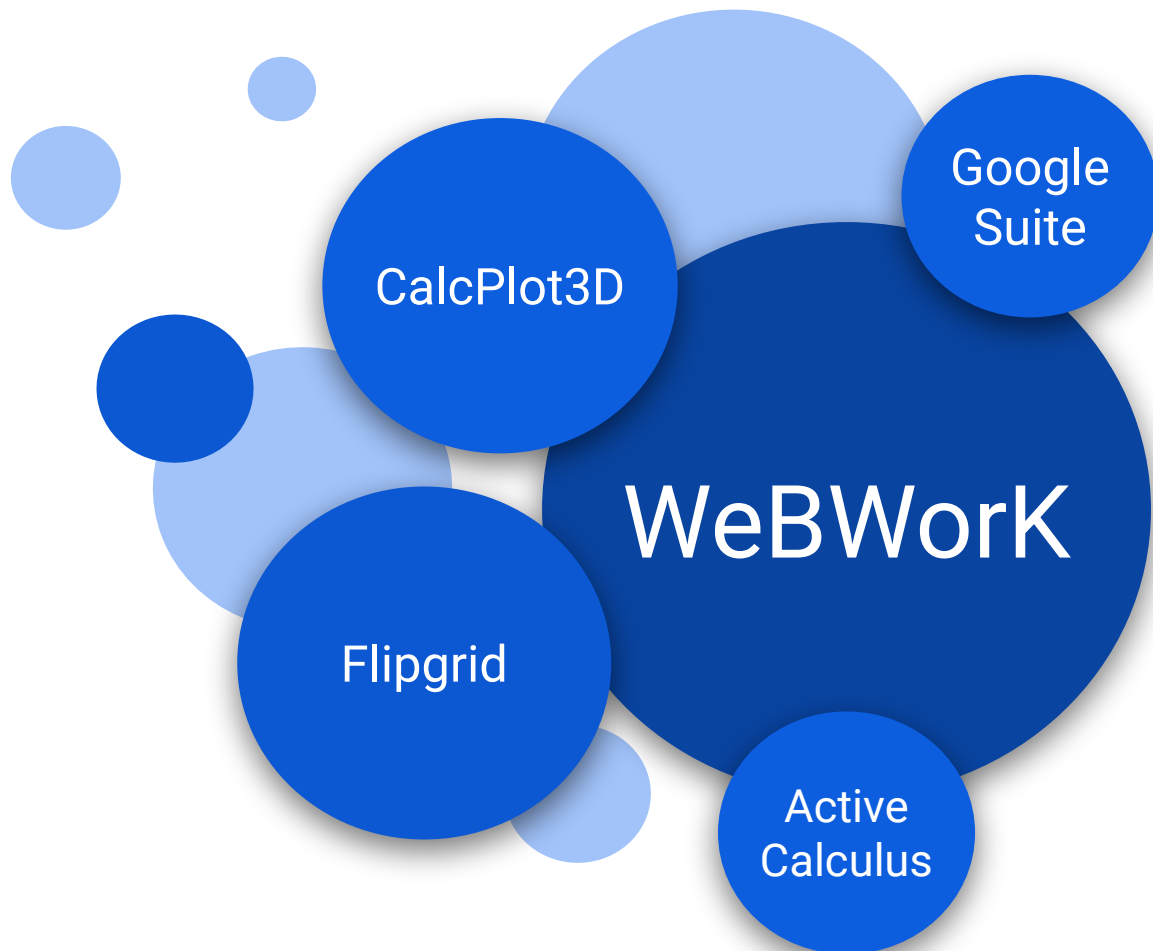
Parametric Curves



Surfaces



Vector Fields & Other Topics



CalcPlot3D

Google
Suite

WeBWorK

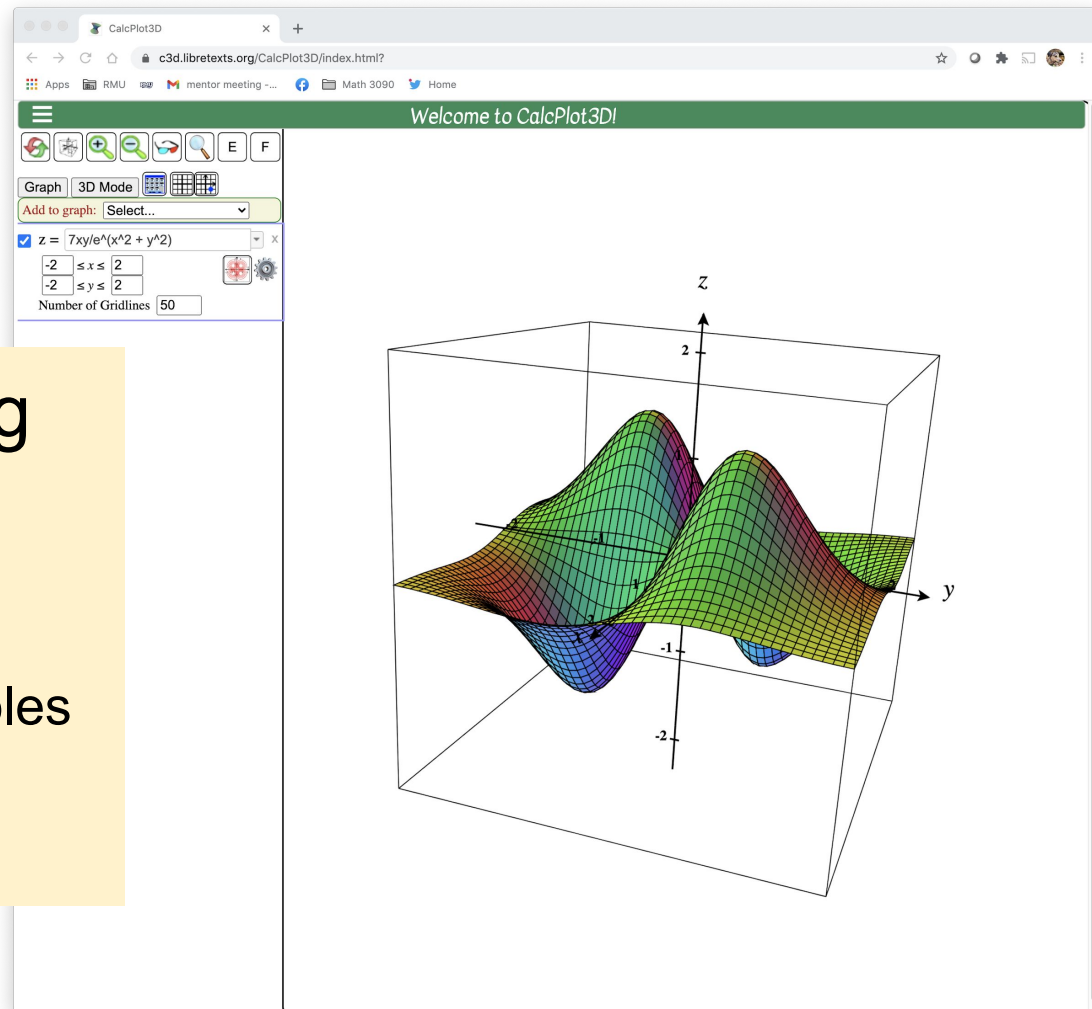
Flipgrid

Active
Calculus



Dynamic 3D-graphing calculator for

- Vectors
- Parametric Curves
- Functions of 2 to 4 variables
- Parametric Surfaces
- Vector Fields





Video Discussion Board

Virtual Study Groups ⊕ Assessments ⊕ Announcements

A video frame showing a person holding a piece of paper with handwritten math work. The work includes the following steps:

$$\frac{\partial S}{\partial a} = 546a + 42b - 144$$
$$\frac{\partial S}{\partial a} = 42a + 6b - 12 \times 7 = \frac{-(294a + 42b - 84)}{252a \quad -60}$$
$$a = 5/21$$
$$0 = 42(5/21) + 6b - 12$$
$$b = 1/3$$
$$y = 5/21x^2 + 1/3$$

The video player interface at the bottom shows a play button, a progress bar at 4:41 / 4:45, and icons for closed captions, settings, and full screen.



Homework Sets

- *Video Lectures*
- *Practice Problems*
- *Flipgrid Challenge*
- *Group Projects*
- *Exams*
- *Course Evaluation*

MAIN MENU
Courses
Homework Sets
User Settings
Grades
Instructor Tools
Classlist Editor
Hmwk Sets Editor
Library Browser
Statistics
arbst195
Student Progress
arbst195
Scoring Tools
Email
File Manager
Course Configuration
Help
?
Report bugs

Math 3090 Fall 2020

Homework Sets			
	Name	Test Score	Test Date
☐	Week0		Closed, answers available.
☐	Week1-Practice		Closed, answers available.
☐	Week1-Videos		Closed, answers available.
☐	Week1-Challenge		Closed, answers available.
☐	Week2-PreviewVideos		Closed, answers available.
☐	Week2-Videos		Closed, answers available.
☐	Week2-Practice		Closed, answers available.
☐	Week2-Challenge		Closed, answers available.
☐	DotProduct Exploration		Closed, answers available.
☐	CrossProductExploration		Closed, answers available.
☐	Week3-PreviewVideos		Closed, answers available.
☐	Week3-Practice		Closed, answers available.
☐	Week3-Videos		Closed, answers available.
☐	Week3-Challenge		Closed, answers available.
☐	Week4-PreviewVideos		Closed, answers available.
☐	Week4-Practice		Closed, answers available.
☐	Week4-Videos		Closed, answers available.
☐	Week4-Challenge		Closed, answers available.
☐	Lines Planes Exploration		Closed, answers available.
☐	Week5-PreviewVideos		Closed, answers available.

WebWork: RMU_Math3090_Fa2020

Not Secure | webwork-test.rmu.edu/webwork2/RMU_Math3090_Fa2020/Week1-Videos/4/?user=vandieren&effectiveUser=vandieren&key...

Apps | RMU | mentor meeting | Math 3090 | Home

MAIN MENU

- Courses
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 - Week1-Videos
 - Problem 4**
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 - Hmwk Sets Editor
 - Week1-Videos
 - 4
 - 4
- Library Browser
- Statistics
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Report bugs

Problems

- Problem 1
- Problem 2
- Problem 3
- Problem 4**
- Problem 5
- Problem 6
- Problem 7
- Problem 8
- Problem 9
- Problem 10

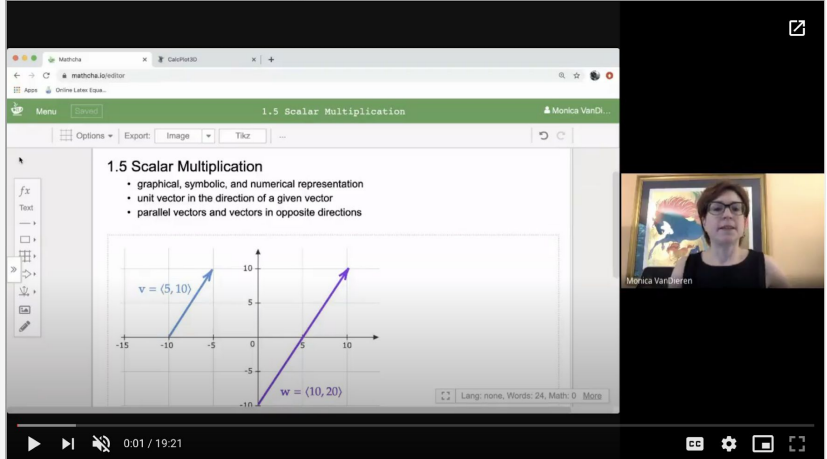
webwork / rmu_math3090_fa2020 / week1-videos / 4

Week1-Videos: Problem 4

Previous Problem | Problem List | Next Problem

This set is visible to students.

(1 point) setWeek1-Videos/vector-scalarmult-video.pg



Watch Week 1 Video 8 (above). This video covers material from section 9.2.4 and 9.2.5 of Active Calculus - Multivariable+Vector. You may download the whiteboard notes [here](#).

When you have finished viewing the video, answer the following questions before proceeding to the next video.

Let $A = (-3, 3, -2)$ and $B = (4, 4, 0)$ be points in $\mathbb{R}^3$.

a. Find a unit vector in the direction of $\overrightarrow{AB}$.

help (vectors)

b. Find a vector in the direction of $\overrightarrow{AB}$ that has length 2.

help (vectors)

Hint:

Videos Problems

Embed URL into new or existing WeBWork problems, solutions, and hints using the iframe command.



WebWork: RMU_Math3090_Fa2020

Not Secure | webwork-test.rmu.edu/webwork2/RMU_Math3090_Fa2020/Week1-Videos/4/?user=vandieren&effectiveUser=vandieren&key=...

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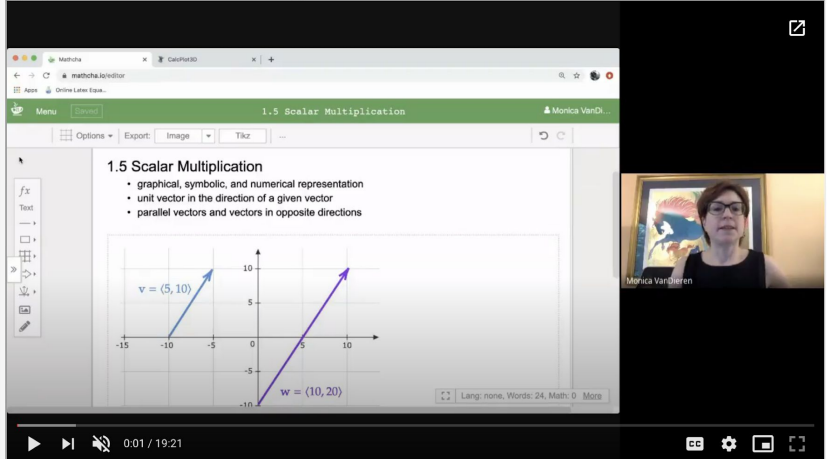
webwork / rmu_math3090_fa2020 / week1-videos / 4

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a. Find a unit vector in the direction of $\overrightarrow{AB}$.

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help (vectors)

Hint:

Videos Problems

Embed URL into new or existing WeBWork problems using the iframe command

This line defines a variable associated with the URL which # houses your video. You can set the # width and height.



```
$video = MODES(
HTML=>
'<iframe height="540px"
src="https://drive.google.com/file/d/1RDkY4KC7Sg_jXZyGuJoUfbnFI
Hxm1iQ9/preview" width="960px"></iframe>',
TeX =>
"A description of your video."
);
```

BEGIN_TEXT

#This line calls places the video in the text of the problem.

\$video

END_TEXT

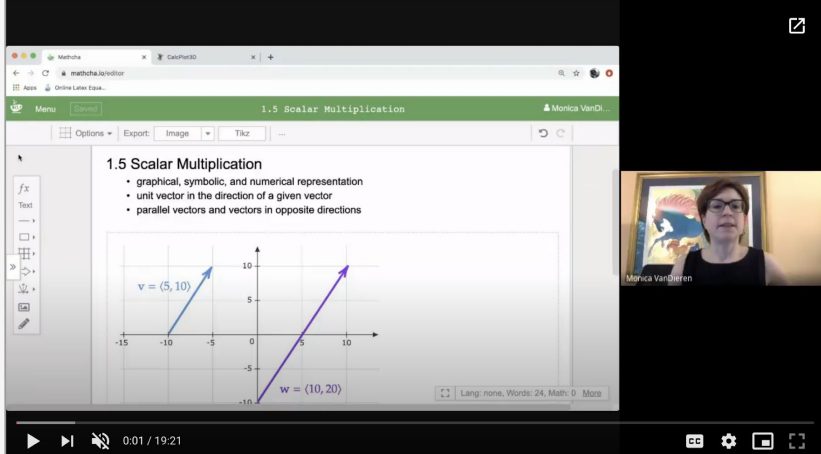
WebWork: RMU_Math3090_Fa2020 / week1-videos / 4

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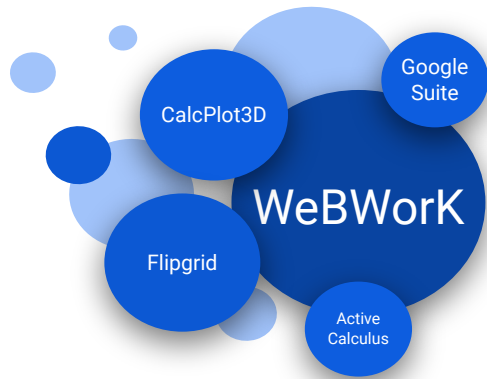
a. Find a unit vector in the direction of $\vec{AB}$. help (vectors)

b. Find a vector in the direction of $\vec{AB}$ that has length 2. help (vectors)

Hint:
.....

Videos Problems

- *Links to Textbook*
- *Links to Handouts*
- *"Exit" Ticket or Concept Checks with Hints*



Integrating Flipgrid and CalcPlot3D into WeBWork problems

Questions: Embed dynamic figure or video into problem

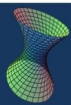
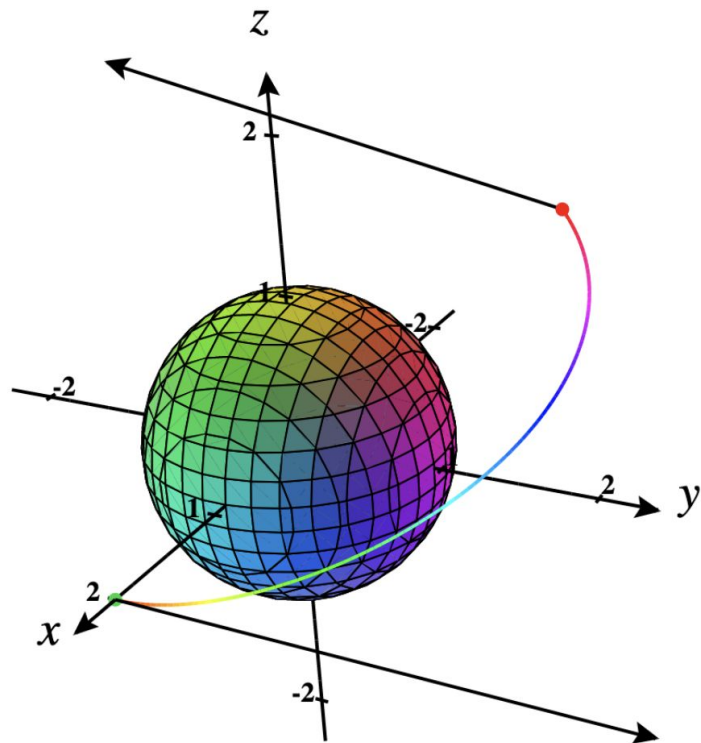
Answers: Copy and paste URL into essay prompt

Student Answers

- Created in CalcPlot3D
- Submitted URL in essay box

Find a Bezier curve that goes through the points $(2,0,0)$ and $(-2,1,1)$ but does not intersect the sphere centered at the origin of radius 1.

Type your solution in the essay box along with a link of a graph of your solution in CalcPlot3D.



CalcPlot3D Questions

Difficult to “google”

- Question prompt includes the graph only (not the formula of the function)

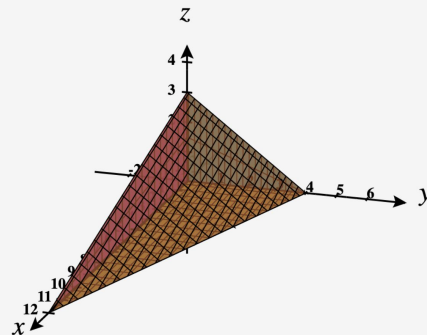
Randomized

- Coefficients
- Points
- Order of integration, etc.

Dynamic

- Rotate and Zoom
- Scrollbars for optional parameters

(1 point) GatewayOrder9/GatewayOrder9.pg



Find the limits of integration $l_x, u_x, l_y, u_y, l_z, u_z$ (some of which will involve variables x, y, z ; the l stands for lower and the u stands for upper) so that

$$\int_{l_z}^{u_z} \int_{l_y}^{u_y} \int_{l_x}^{u_x} dx \, dy \, dz$$

represents the volume of the solid graphed above. This solid lies in the region in the first octant that is bounded by the 3 coordinate planes and the plane

$$x + 3y + 4z = 12.$$

CalcPlot3D Questions

#defining a randomized plane

```
do {
  $b=random(2,4,1);
  $c=random(2,6,1);
  $d = $b * $c;
} until ($d < 12);
$plane = Compute("x + $b y + $c z")->reduce;
$top2d = "-1/$b*x+$c";
$top3d = "($d-x-$b*y)/$c";
```

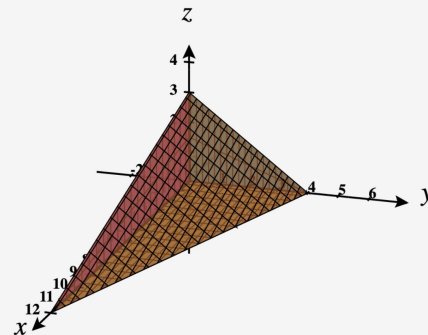
#URL for the dynamic CalcPlot3D figure using the variable coefficients defined above

```
$iframe_src =
qq(https://c3d.libretexts.org/CalcPlot3D/dynamicFigure/index.html?type=region;region=x;visible=true;alpha=19
6;view=0;top2d=$top2d;bot2d=0;umin=0;umax=12;top3d=$top3d;bot3d=0;grid=25,40;showriemann=false;xnu
m=4;ynum=4;partition=Inner;heightpt=0;showpts=false;mode=rect;polarform=t;polarbottom=0;polar
min=%CF%80/4;polarmax=3%CF%80/4&type=slider;slider=b;value=3;steps=100;pmin=1;pmax=2;repeat=true;
bounce=true;waittime=1;careful=false;noanimate=false;name=-1&type=slider;slider=c;value=4;steps=100;pmin
=3;pmax=6;repeat=true;bounce=true;waittime=1;careful=false;noanimate=false;name=-1&type=z;z=(b*c-x-b*y)
/c;visible=false;umin=-2;umax=12;vmin=-2;vmax=6;grid=30;format=normal;alpha=-1;constcol=rgb(255,0,0);vie
w=0;contourcolor=red;fixdomain=false&type=slider;slider=b;value=3;steps=100;pmin=-2;pmax=2;repeat=true;b
ounce=true;waittime=1;careful=false;noanimate=false;name=-1&type=window;hsmode=3;nomidpts=true;anagl
yph=-1;center=8.072107952730187,3.622423001468024,4.660378181854415,1;focus=0,0,0,1;up=-0.4079746
96070664,-0.22819763077574778,0.884014982154932,1;transparent=false;alpha=140;twoviews=false;unlinkv
iews=false;axisextension=0.7;xaxislabel=x;yaxislabel=y;zaxislabel=z;edgeson=true;faceson=true;showbox=fals
e;showaxes=true;showticks=true;perspective=true;centerpercent=0.5;centerpercent=0.5;rotationsteps=30;au
tospin=true;xygrid=false;yzgrid=false;xzgrid=false;gridsonbox=true;gridplanes=false;gridcolor=rgb(128,128,128
);xmin=-2;xmax=12;ymin=-2;ymax=6;zmin=-2;zmax=4;xscale=1;yscale=1;zscale=1;zmin=-4;zmax=6;zoom=0
.356639;xscalefactor=1;yscalefactor=1;zscalefactor=1);
```

#variable to call in the text block in order to generate the iframe figure from the url in the text block of the problem

```
$plot = MODES(HTML=>
qq(<iframe height="600px" src="$iframe_src" width="90%"></iframe>),
TeX=>"An embedded dynamic figure.");
```

(1 point) GatewayOrder9/GatewayOrder9.pg



integration $\int_L u_x, u_y, u_z$ (some of which will involve variables x, y, z ; the l stands for lower and the u stands for upper) so

$$\int_{L_x}^{u_x} \int_{L_y}^{u_y} \int_{L_z}^{u_z} dx dy dz$$

Volume of the solid graphed above. This solid lies in the region in the first octant that is bounded by the 3 coordinate planes and

$$x + 3y + 4z = 12.$$

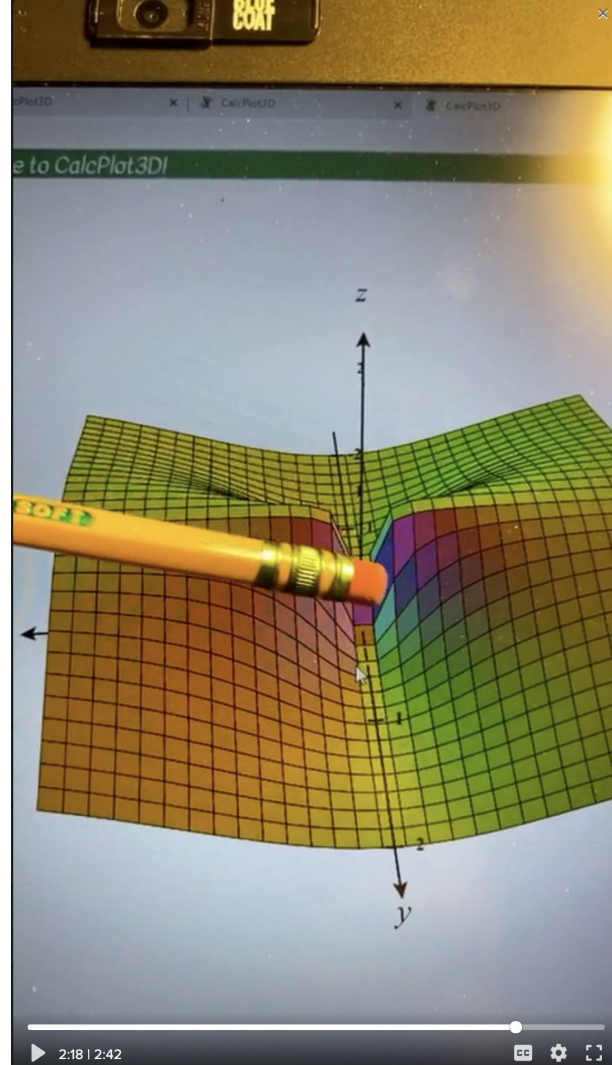
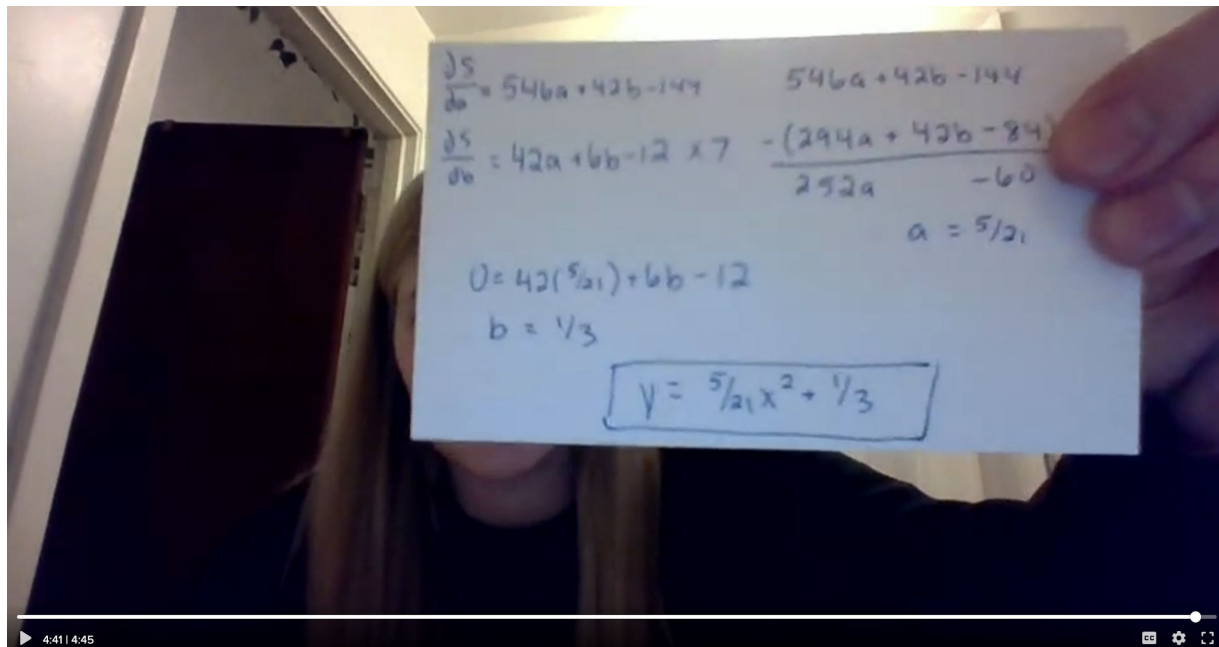


WebWork

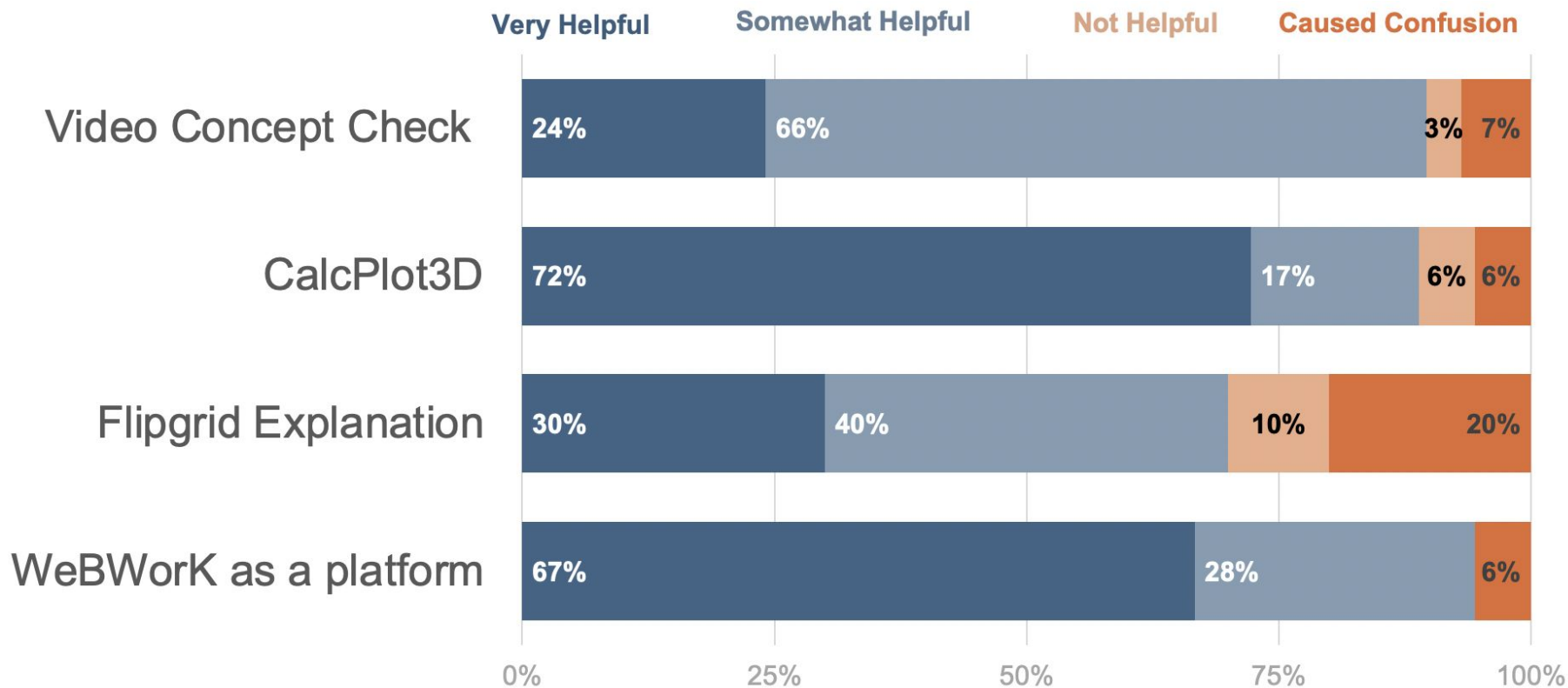
Student Answers

- Created in Flipgrid
- Submitted URL in essay box

FLIPGRID



Student Evaluation of Components:



Thank you.



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This material is based upon work supported by the National Science Foundation under a collaborative research Grant No. 1523786.