Improving Undergraduate STEM Visualizations Through Design Education: A NASA-funded STEAM Curriculum Initiative

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Overview
Overview

The Need
Overview

The Need

The Teaching Model
Overview

The Need

The Teaching Model

The Funding Process
Overview

The Need

The Teaching Model

The Funding Process

The Course
Overview

The Need

The Teaching Model

The Funding Process

The Course

Student Outcomes
Overview

The Need

The Teaching Model

The Funding Process

The Course

Student Outcomes

Pedagogical Reflection
Overview
The Need
The Teaching Model
The Funding Process
The Course
Student Outcomes
Pedagogical Reflection
Reproducibility
The Need

Poor standard of STEM undergraduate visualizations
The Teaching Model

STEAM EDUCATION INITIATIVE

Started in 2006
STEM
(Science, Technology, Engineering, Math) + ART
The Teaching Model

STEAM EDUCATION INITIATIVE

Started in 2006

Design incorporated into STEAM in 2010
STEM
(Science, Technology, Engineering, Math) + ART + DESIGN
The Teaching Model

STEAM EDUCATION INITIATIVE

Started in 2006

Design incorporated into STEAM in 2013

Implemented in University of Nevada Reno's art department
The Teaching Model

STEAM EDUCATION INITIATIVE

Started in 2006

Design incorporated into STEAM in 2013

Implemented in University of Nevada Reno's art department

First time implemented in College of Science at UNR
The Funding Process

Finding the grant opportunity
NASA NV Space Consortium Curriculum Development Grant
The Funding Process

Finding the grant opportunity

Assembling the team
The Funding Process

Finding the grant opportunity

Assembling the team

Writing the proposal
The Funding Process

Finding the grant opportunity

Assembling the team

Writing the proposal

Seeking internal university approval
The Funding Process

Finding the grant opportunity

Assembling the team

Writing the proposal

Seeking internal university approval

Making requested revisions
NASA NV Space Consortium Curriculum Development Grant

$35,990
The Funding Process

WHY DID WE SEEK FUNDING?
The Funding Process

WHY DID WE SEEK FUNDING?

Get help with teaching and research
The Funding Process

Why did we seek funding?
Get help with teaching and research
Fund necessary teaching purchases
The Funding Process

WHY DID WE SEEK FUNDING?

Get help with teaching and research

Fund necessary teaching purchases

Help the initiative to be taken seriously by administrators
The Funding Process

WHY DID WE SEEK FUNDING?

Get help with teaching and research

Fund necessary teaching purchases

Help the initiative to be taken seriously by administrators

Strengthen our tenure and promotion cases
The Course

COMPUTATIONAL SKILLS FOR BIG DATA: ANALYSIS, STATISTICS, & VISUALIZATION
The Course

COMPUTATIONAL SKILLS FOR BIG DATA: ANALYSIS, STATISTICS, & VISUALIZATION

Spring 2017
The Course

COMPUTATIONAL SKILLS FOR BIG DATA: ANALYSIS, STATISTICS, & VISUALIZATION

Spring 2017

16 week pilot course
The Course

COMPUTATIONAL SKILLS FOR BIG DATA: ANALYSIS, STATISTICS, & VISUALIZATION

Spring 2017

16 week pilot course

4 students
The Course

COURSE STRUCTURE
The Course

COURSE STRUCTURE

Section 1: big data, 8 weeks
The Course

COURSE STRUCTURE

Section 1: big data, 8 weeks

Section 2: statistics, 8 weeks
The Course

COURSE STRUCTURE

Section 1: big data, 8 weeks

Section 2: statistics, 8 weeks

Section 3: visualization, 8 weeks
(online component concurrent with statistics)
The Course

SECTION 3: VISUALIZATION
The Course

SECTION 3: VISUALIZATION

PRIMARY GOAL
Improve STEM students’ data visualization skills through incorporating communication design perspectives on data visualization
The Course

SECTION 3: VISUALIZATION

PRIMARY GOAL
Improve STEM students’ data visualization skills through incorporating communication design perspectives on data visualization

SECONDARY GOAL
Teach students the difference between data visualization for analysis and data visualization for sharing knowledge, and to apply relevant skills to each scenario
Visualization for analysis
China CO2 Emissions
China CO2 Emissions

Year

CO2 Emissions
Weight vs Horsepower of Cars

Models built between 1952-1992

- 8 Cylinder cars
- 6 Cylinder cars
- 4 Cylinder cars

CHART MADE IN R
Visualization for sharing knowledge
The Course

SECTION 3: VISUALIZATION SOFTWARE

R
# PHYS483 Visualization Module Component
# Written by Dr Katherine Hepworth | https://kathep.com

This activity relies on a built-in dataset in R, so there is no need to call the data.

#### Activity 1: Change the position of the legend
(options are: none, top, bottom, right)

kh_theme=theme_bw()+
  theme(panel.grid.major=element_line(color = '#E0E0E0'),
  panel.grid.minor=element_line(color = '#E0E0E0', linetype = 'dotted'),
  panel.border=element_blank(),
  # Adds white space around chart and labels
  plot.margin=unit(c(8,12,8,8),'mm'),
  # Formats the caption
  plot.caption=element_text(face='italic', color = '#666666'),
  # Creates an L shaped line for axes
  axis.line=element_line(),
  # Makes most text black
  text=element_text(color='black'),
  # Makes axis tick labels black
  axis.text = element_text(color='black'),
  # Changes title size and font weight to bold
  plot.title = element_text(face='bold', size=26,
    # Adds a little space between title and chart
    margin=margin(0,0,10,0)),
  #
  # Step 1: Change the position of the legend
  legend.position = 'right',
  # Removes legend title
  legend.title = element_blank(),
  # Changes font weight and size for the axes labels
  axis.title = element_text(face='italic', size=15))

#### Activity 2: Choose colors for plot points and customize legend

# Step 1: Choose three mid-low saturation colors from
The Course

SECTION 3: VISUALIZATION

SOFTWARE

R
open source statistical analysis program
The Course

SECTION 3: VISUALIZATION

SOFTWARE

R

open source statistical analysis program extensible through packages
The Course

SECTION 3: VISUALIZATION

SOFTWARE

R
open source statistical analysis program
extensible through packages
  ggplot — sophisticated charting
The Course

SECTION 3: VISUALIZATION

SOFTWARE

R
open source statistical analysis program
extensible through packages
  ggplot — sophisticated charting
  showtext — render non-default fonts
The Course

SECTION 3: VISUALIZATION

SOFTWARE

R

open source statistical analysis program
extensible through packages
  ggplot — sophisticated charting
  showtext — render non-default fonts
  assertthat — check functions
The Course

SECTION 3: VISUALIZATION

SOFTWARE

R
open source statistical analysis program
extensible through packages
  ggplot — sophisticated charting
  showtext — render non-default fonts
  assertthat — check functions
  scales — determine custom date breaks
The Course

SECTION 3: VISUALIZATION

SOFTWARE

R

don open source statistical analysis program
extendible through packages
  ggplot — sophisticated charting
  showtext — render non-default fonts
  assertthat — check functions
  scales — determine custom date breaks
  colorspace — converts all color specification methods
The Course

SECTION 3: VISUALIZATION

SOFTWARE
Plot.ly
The Course

SECTION 3: VISUALIZATION

SOFTWARE

Plot.ly
online interactive chart builder
The Course

SECTION 3: VISUALIZATION

DESIGN PRINCIPLES TAUGHT
The Course

SECTION 3: VISUALIZATION

DESIGN PRINCIPLES TAUGHT

Typography — typefaces, weights, legibility, contrast
The Course

SECTION 3: VISUALIZATION

DESIGN PRINCIPLES TAUGHT

Typography — typefaces, weights, legibility, contrast

Color — hue, saturation, combining colors
The Course

SECTION 3: VISUALIZATION

DESIGN PRINCIPLES TAUGHT

Typography — typefaces, weights, legibility, contrast

Color — hue, saturation, combining colors

Visual hierarchy — composition, emphasis, eye gaze
Student Outcomes

Students' visualization skills improved
Reflection

Getting the grant was the easy part
Reflection

Getting the grant was the easy part

Differing disciplinary expectations must be navigated
Reflection

Getting the grant was the easy part

Differing disciplinary expectations must be navigated

I underestimated the work involved
Reflection

Getting the grant was the easy part

Differing disciplinary expectations must be navigated

I underestimated the work involved

With careful planning, this model is replicable
Reflection

Getting the grant was the easy part

Differing disciplinary expectations must be navigated

I underestimated the work involved

With careful planning, this model is replicable

I would do it again
Reproducibility

Communication design and any STEM field
Reproducibility

Communication design and any STEM field

Tell people what you do—in detail
Reproducibility

Communication design and any STEM field

Tell people what you do—in detail

Ask STEM colleagues what they do—listen to the details
Reproducibility

Communication design and any STEM field

Tell people what you do—in detail

Ask STEM colleagues what they do—listen to the details

Forge interdisciplinary friendships
Reproducibility

Communication design and any STEM field

Tell people what you do—in detail

Ask STEM colleagues what they do—listen to the details

Forge interdisciplinary friendships

Sign up for institutional grant listservs
Reproducibility

Communication design and any STEM field

Tell people what you do—in detail

Ask STEM colleagues what they do—listen to the details

Forge interdisciplinary friendships

Sign up for institutional grant listservs

Read grant calls for participation with an eye for design opportunities
Conclusion

STEAM collaborations between STEM and communication design educators can be very beneficial to students
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Communication design + STEM collaborations have huge growth potential.
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Communication design + STEM collaborations have huge growth potential.

Programming skills are valuable for interdisciplinary collaboration.
Thank you

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