Improving Physics Undergraduates Visualization Skills for More Effective Learning and Science Communication

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Overview
Overview

The Need
Overview

The Need

The Teaching Model
Overview

The Need

The Teaching Model

The Course
Overview

The Need

The Teaching Model

The Course

Student Outcomes
Overview

The Need

The Teaching Model

The Course

Student Outcomes

Pedagogical Reflection
Overview

The Need

The Teaching Model

The Course

Student Outcomes

Pedagogical Reflection

Reproducibility
The Need

STEM undergraduate students are required to visualize complex processes, but rarely receive explicit training in visualization.
The Need

STEM undergraduate students are required to visualize complex processes, but rarely receive explicit training in visualization

Leads to poor visualization
Current and Radiation Signals

- SiD, 53 keV
- XRD
- PCD
- TQPH
- TGSP
- Current

EUV: >17 eV
XRD: >0.2 keV
PCD: >0.7 keV

Figure 1

Energy released by fusion
Mass number (A)
The Teaching Model

STEAM EDUCATION INITIATIVE

Started in 2006
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 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

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

Spring 2017

16 week pilot course

4 students

Physics majors
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 principles regarding data visualization
The Course

SECTION 3: VISUALIZATION

PRIMARY GOAL
Improve STEM students’ data visualization skills through incorporating communication design principles regarding 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

Year

CO2 Emissions
China 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
Science communication: 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(panels.grid.major=element_line(color = '#E6E6E6'),
        panels.grid.minor=element_line(color = '#E6E6E6'),
        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))
```
The Course

SECTION 3: VISUALIZATION

SOFTWARE

R
ggplot — sophisticated charting
The Course

SECTION 3: VISUALIZATION

SOFTWARE

R

  ggplot — sophisticated charting
  showtext — render non-default fonts
The Course

SECTION 3: VISUALIZATION

SOFTWARE

R

ggplot — sophisticated charting
showtext — render non-default fonts
assertthat — check functions
The Course

SECTION 3: VISUALIZATION

SOFTWARE

R

- ggplot — sophisticated charting
- showtext — render non-default fonts
- assertthat — check functions
- scales — determine custom date breaks
The Course

SECTION 3: VISUALIZATION

SOFTWARE

R

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

Differing disciplinary expectations must be navigated
Reflection

Differing disciplinary expectations must be navigated
Reflection

Differing disciplinary expectations must be navigated

With careful planning, this model is replicable
Reflection

Differing disciplinary expectations must be navigated

With careful planning, this model is replicable
Reproducibility

Online visualization module format widely reproducible
Reproducibility

Online visualization module format highly reproducible

Find communication design faculty on your campus
Reproducibility

Combining any STEM field and communication design

Find communication design faculty on your campus

Talk with them
Publications

Publications


Conclusion

STEAM collaborations between STEM and design faculty can be very beneficial to students learning and science communication.
Conclusion

STEAM collaborations between STEM and design faculty can be very beneficial to students learning and science communication.

STEM + communication design collaborations have huge growth potential.
Thank you

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