Hand-size versus Height:
a Real-time hands-on activity

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Outline of the Presentation

• What/Why using real-time online hands-on activities

• Demonstrate the Hand-size Vs. Height activity:
  – Issues related to data production
  – Bivariate relationship
  – Instructional materials
  – Assessment materials

• Benefits and Challenges

• First Time user
What is a real-time hands-on activity

• It is a hands-on activity
• It collects students’ own data
• Data are entered through Internet to the STATACT site at http://stat.cst.cmich.edu/statact/
• Data are accumulated in an online data base.
• Data are ready for downloading for instructional use immediately after entry.

Navigation of the Real-time site
Why Real-time data Generated by Students?

This makes it possible to conduct the entire process of statistical investigation in an introductory statistics course.
Activity: How well can hand-size predict height?

The learning goals: By the end of the activity, students are expected to be able to:

• Explain the importance of data measurement and production in a given context, and choose a measurement that is more robust to the environment.
• Apply graphical and numerical techniques to describe and interpret the relationship between two variables.
• Explain the least square method in a given context.
• Distinguish between causation and association.
• Apply residual plots to determine if linear model is appropriate.
• Identify outlying cases and determine their effects.
The context for using this activity

- The activity is appropriate for introductory statistics at high school or university.
- The activity can be used as an individual or group project.
- Time needed to conduct the activity is about ten minutes (including data measurement, entry and downloading) for the entire class.
- Prior to conducting the activity: The instructor needs to
  - register on the Real-time online site to request for the ACTIVITY CODE
  - Prepare one-foot long paper rulers or actual rulers.
  - Prepare a worksheet with assessment questions. You can download the Activity-worksheet and the data set (hand-size data (50cases)) used for this worksheet. You can modify this worksheet or create your own.
Teaching Notes to facilitate the activity

During the session of facilitating the activity:

• Start with proposing the problem to be investigated: How well can your hand size predict your height?

• Discuss the issues related to data measurement:
  – how to measure hand-size,
  – is the measurement measures hand-size?
  – Is the measure easy to measure?
  – how well can it be measured repeatedly?

NOTE: Two measures of the hand-size that students will collected are Hand-length (from wrist to tip of middle finger) and Hand-width (the tip of thumb to tip of little finger with the hand completely expended).

GO TO STATACT site to demonstrate data entry and download
• Discuss the data quality issues such as
  – data measurement error: using centimeter vs. inch; Hand-width is shorter than hand-length (NOTE: If the measurements are properly measured, then Hand-width is always larger than hand-length)
  – Data entry error,
  – outliers

• Discuss the relation between Height and Hand-length by introducing
  – Scatter plot, correlation,
  – least square method, build simple linear regression,
  – Causation Vs. Association,
  – $R^2$, Residual plots for model diagnosis,
  – ANOVA table, Confidence interval and testing hypothesis for slope.
In the second part of the Worksheet activity, students are asked to browse through the data and to see if there are ‘unusual’ data.

Some students may notice there are some missing cases, and some students may notice some very small hand_width. For this data, case 79 and case 81 are two ‘unusual cases whose hand_width are 4’’ and 5”, respectively.

Students are asked to discuss possible reasons.

These cases are then deleted, students are asked to reanalyze the data and compare the results with the first analysis. Students are then asked to discuss the impact of these ‘unusual’ cases.
Unique Opportunity for discussing issues related to data measurement and production

Data are accumulated. The data are messy. It provides an unique opportunity to address the issues related to data measurement and data production. The following table summarizes the issues related to data production using the real-time activities:

<table>
<thead>
<tr>
<th>Choice of measurement units</th>
<th>Distance, Hand_size, Exercise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robustness of measuring techniques</td>
<td>Distance, Hand_size, Exercise</td>
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<tr>
<td>The operational definition of variable</td>
<td>Distance, Hand_size, Exercise</td>
</tr>
<tr>
<td>Subjective sampling or random sampling</td>
<td>Sampling, Vote, Random_selection, Raisins</td>
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<td>Outliers Vs. errors</td>
<td>Distance, Hand_size, Exercise</td>
</tr>
<tr>
<td>Observational Vs. experimental study</td>
<td>Exercise, Vote, Colleg_life, Random_selection</td>
</tr>
<tr>
<td>Underline target population</td>
<td>Raisins, Vote, Distance</td>
</tr>
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</table>
Instructional Materials for introducing bivariate relationship using Hand-size activity

- **A set of Power Point Slides for instruction**
- **The Hand-size data set used in the power point slides**

Assessment Materials for Bivariate Relationship

- **Activity Worksheet**
- **Hand-size data for the Activity Worksheet**
- **Activity Worksheet – using Online Applet**
- **Some additional questions for assessment**
Benefits that we have noticed

- Creates an environment for students to experience and practice the cycle of statistical investigation, from data measurement to presentation.
- Active learning is an immediate consequence.
- Students’ own data motivates students better.
- Easy to assign projects.
- Allows instructors to share their activities data online.
- Allows different classes to use the same project in different semesters with different data sets.
- It is able to accomplish the recommendations by the GAISE Report.
Obstacles we Have Experienced

• It requires computer lab and Internet access, if you would like to have your students to conduct the activities.
• Some students do not have adequate computer background. Some additional preparation about the computer basics may be needed.
• Students learned their mathematics by lecture with step-by-step procedures. Having students to be active learners encounters resistance in some cases.
Suggestions to First Time Users

(A) Start with one activity that you feel most comfortable and you think students will have the most benefits.

Two most popular activities are Hand-size activity and Raisins Activity.

(B) Take the opportunity to discuss data measurements and data quality.

(C) Engage students whenever possible. Students are eager to participate, if given opportunity.

(D) Use the technology that you are most familiar with and easy for students to learn.

(E) Plan ahead. Get familiar with the data entry, data download and how to use your local technology to read the .dat data.

(F) Keep students informed on what you plan to do and how the activity will be assessed.

If you need any help, please let me know. Simply e-mail me, or call me.
References

• The Real-time online Hands-on Activity web site: http://stat.cst.cmich.edu/statact/
• Online Applet for demonstrating bivariate relationship
• SERC Pedagogy Service Project on CAUSE web site

Contact Information: Carl Lee
e-mail: carl.lee@cmich.edu
Just In case, if technology does not work. The following slides are screen shots to demonstrate the process of using the Real-time activities.
Welcome to the Statistics Action Home Page:
Real-Time Online Activities for Statistics

Real Time Online Hands-on Activities

An online database that hosts the data collected from in-class hands-on activities conducted by students.

If your answer to any of the following questions is "YES", then, this Real-Time Online Database should be beneficial to your class.

- Do you use hands-on activities in your class?
- Would you like to share your hands-on activities?
- Would you be interested in using data collected by students from classes in different institutions?
- Would you be interested in sharing your students' data with others?

This Real-Time Online Database is the result from a NSF/CCLI project under the grant #0310932. The goal of the project is to adapt, implement and evaluate an Activity-Based, Cooperative learning and Technology (ACT) curriculum in statistics courses for non-majors and prospective K-12 teachers. The guiding principles are:

- People learn better by constructing knowledge themselves through guided processes.
- Practice and feedback are essential ingredients for understanding new concepts.
- Active problem-solving through teamwork promotes active learning.
General Directions for Participation

You are about to participate in a real-time online hands-on activity. There are two ways to participate in the activity:

1. Participate in Collecting Data for the online hands-on activity:

(A) For Instructors:
For each activity, an activity pass code is required. To obtain the Pass Codes, please register to submit your request. You will receive a list of activity pass codes by e-mail in a few minutes. The Instruction for facilitation page provides general guidelines for facilitating the online activities. Once you have the activity pass codes, you are ready to facilitate the real-time online activity.

Click on Data Entry to begin.

(B) For Students:
Please click on Instruction for participation to read the Guidelines for Participation. After reading the guidelines, return to this page then wait for directions from your instructor.

II. Use the data available on the database for class activities or homework activities. NO PASS CODE is needed.
You can go directly to the Data Download page to download the data.
40+5 is the maximum # of data entries for each activity.

### Registration Form for Online Hands-on Activities

<table>
<thead>
<tr>
<th>Name *</th>
<th>Carl Lee</th>
</tr>
</thead>
<tbody>
<tr>
<td>Email *</td>
<td><a href="mailto:carl.lee@cmich.edu">carl.lee@cmich.edu</a></td>
</tr>
<tr>
<td>Email (re-enter for validation) *</td>
<td><a href="mailto:carl.lee@cmich.edu">carl.lee@cmich.edu</a></td>
</tr>
<tr>
<td>Affiliation *</td>
<td>Central Michigan Univ</td>
</tr>
<tr>
<td>Phone (work) *</td>
<td>(989)774-3555</td>
</tr>
<tr>
<td>Street/Road *</td>
<td>PE109</td>
</tr>
<tr>
<td>City, State, Zip Code *</td>
<td>Mt. Pleasant, MI 48853</td>
</tr>
</tbody>
</table>

I want to register for the following activities: **

**NOTE:** The Activity: **College Life** is currently not available. Please do not use this activity. Sorry about the inconvenience.

- [ ] Distance: How far are you away from home?
- [ ] Hand_Size: Is hand size a good predictor of height?
- [ ] Exercise: How does one minute of exercise affect your pulse rate?
- [ ] Raisins: How many raisins in a 1/2 oz box?
- [ ] Colleage-Life: Are you satisfied with your university?
- [ ] Left_Right_Hand: Are you left handed or right handed?
- [ ] Sampling: Random sampling v. subjective sampling. Which is better?
- [ ] Voter Awareness: Which party will you vote for?
An e-mail consisting of a welcome message, registered information and the activity codes:

Name: __________________________ Email: __________________________ Phone: __________________________
Affiliation: __________________________ Address: __________________________

Activity Code | Activity List
---|---
ACT1145808371 | Activity Distance
ACT1145808372 | Activity Hand_size
ACT1145808373 | Activity Exercise
ACT1145808374 | Activity Raisins
0 | Activity College_Life
ACT1145808376 | Activity Left_Right_Handed
ACT1145808377 | Activity Sampling
ACT1145808378 | Activity Vote
ACT1145808379 | Activity Draw_Line
ACT1145808380 | Activity Random Select

Each activity code is valid for three months starting from the 1st data is collected.
If it expired, you can register again for a new set of activity codes.
Real Time Online Hands-on Activities

Online Activity

Data Entry

For Instructor: A pass code is needed for data collection for each online activity. Please register for the pass codes.

For students: For the activity you are about to participate, a pass code will be provided by your instructor. Students DO NOT register for pass codes.

Select the activity your class is participating in to begin.

<table>
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<th>Title</th>
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<tbody>
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</tbody>
</table>
Conduct the Hand Size Activity

Purpose of the Activity:

1. Introduce the importance of measurement.
2. Introduce correlation, scatter plots.
3. Introduce the difference between causation and association.
4. Introduce the Least Square method and simple linear regression.
5. Introduce outliers and the effect of outlier in Y and influential cases in X.

In-class discussions:

• Discuss the issues of measurement.
• Is Hand Length a better measure or Hand Width? Why?
• Which one, Hand Length or Hand Width, is expected to have larger variation?

Distribute the worksheet, a paper rule. Work through some of the questions in class. Leave others as homework.
Activity Hand_Size

Is Hand Size a Good Predictor of Height?

For Instructors: Do you have the pass code for this activity?
For Students: Have you read the Instruction for Participation page?

The Problem

Is hand size a good predictor of height? You are about to collect your own data to find out if hand size and height are correlated and if we can make a good prediction of height using hand size. However, we first need to decide how to measure hand size.

Objectives

1. Learn the importance of proper measurement.
2. Learn the construction of scatter plots and correlations.
3. Learn the concept of relationships between two variables.
4. Learn the least squares method.
5. Learn the concept of model fitting and prediction.
6. Learn how to interpret a regression model.

Key Concepts

Scatter plots, correlation, least square method, simple linear regression, slope and residuals.

Other Related Topics
Activity Hand_Size: Is Hand Size a Good Predictor of Height?

Please take your time and participate in this activity.

How to measure hand size: A discussion should be conducted to brainstorm different ways to measure hand size along with pros and cons for these different measurement methods.

In the following data entry table, we will measure hand size by measuring:

Hand-length: wrist to the top of the middle finger, and

Hand-width: from the tip of the thumb to the tip of the pinky when you expand your hand as much as you can (this is for consistency).

All fields must be filled. Double check that the data is correct before submission.

I am a/an
Activity Code
Gender
Hand-length (wrist to top of middle finger)*
Hand-width (tip of thumb to tip of little finger)
*Note: Hand has to be stretched out, meaning the fingers should be spread as much as possible.
Your height * (XX.X)

Select One
ACT1145808372
Select One
Select One

There are two choices: Instructor, Student. This allows the instructor to practice. The instructor’s data will also be recorded.

From the registration. Provided by the instructor.
Variable Descriptions

Activity Hand_Size: Is hand size a good predictor of height?

Following is a descriptive table of all of the input expected by the user. This table can be used to match the Variable Labels, as seen as the previous page, with the Variable Names, which will be the column headings in the data download.

Download this table in Word (.doc) format or Adobe .pdf format.

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Variable Label</th>
<th>Possible Values</th>
<th>Data Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>user_type</td>
<td>User type</td>
<td>Student, Instructor</td>
<td>text</td>
</tr>
<tr>
<td>Gender</td>
<td>Gender</td>
<td>Male, Female</td>
<td>text</td>
</tr>
<tr>
<td>Hand_Lenth</td>
<td>Hand-length (wrist to top of middle finger)</td>
<td>user entry</td>
<td>numerical</td>
</tr>
<tr>
<td>Hand_Width</td>
<td>Hand-width (thumb to little finger)</td>
<td>user entry</td>
<td>numerical</td>
</tr>
<tr>
<td>Height</td>
<td>Your height in inches (XXX)</td>
<td>user entry</td>
<td>numerical</td>
</tr>
</tbody>
</table>

Download this table in Word (.doc) format or Adobe .pdf format.
Real Time Online Hands-on Activities

Data Analysis

By this time, you should have a data set downloaded and ready for analysis. You may use the software in your local computer lab. Please follow the instructor’s directions.

In the following, we provide some instructional materials for MINITAB and SPSS:

- Minitab instructions
- SPSS instructions

For more rigorous training on SPSS, go to the site:

- Online SPSS Training Workshop

If you do not have commercial statistical software, there is an online statistical analysis tool available: go to the site:

- Statcrunch Online Data Analysis Tools

The following Power Point Slides take you step by step about

- How to download and save data.
- How to read the data using
  - Minitab
  - Excel
  - SPSS
  - Statcrunch

Instruction on How to Download, Save and Read Data
Data Download

For Instructor: If your class only wants to use the data collected by other classes, you do not need to register for pass codes.

Select the activity your class is participating to download the data.

<table>
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</table>

There are two options you have to analyze the above data sets:

- Use the software in your local computer lab.
- Use the online software, namely Crunch_It at: [http://www.statcrunch.com/](http://www.statcrunch.com/)

The following Power Point Slides take you step by step about

- How to download and save data.
- How to read the data using
  - Minitab
  - Excel
  - SPSS
  - Statcrunch

**Instruction on How to Download, Save and Read Data**
Data Download

Activity Hand size: Is hand size a good predictor of height?

Select your data based on the instructions given by the instructor.

- Select all cases.
- Select students only.
- Select all data from my class. (Enter activity code)
- Select ______ most recent cases.
- Select ______ random cases.

Download Data  Reset

I use this most often.

Use this for projects. So that every group will have different data sets.

Please save the data before you open it. The default file name is "mydata.dat". The first record is the variable name. Data values are tab delimited.

* If you leave any fields blank by default all data will be selected.
** If you leave this unchanged by default all data or miles 0 to 15000 will be selected.
Real Time Online Hands-on Activities

Data Download

File Download

Do you want to save this file?

Name: mydata.dat
Type: Unknown File Type, 557 bytes
From: stat.cst.cmich.edu

Save Cancel

While files from the Internet can be useful, some files can potentially harm your computer. If you do not trust the source, do not save this file. What's the risk?

Select 100 most recent cases.

Select _ random cases.

Download Data Reset

Please save the data before you open it. The default file name is "mydata.dat". The first record is the variable name. Data values are tab delimited.

* If you leave any fields blank by default all data will be selected.
** If you leave this unchecked by default all data or all cases will be selected.
Please save the data before you open it. The default file name is "mydata.dat". The first record is the variable name. Data values are tab delimited.

* If you leave any fields blank by default all data will be selected.
** If you leave this unchanged by default all data or miles 0 to 15000 will be selected.
Always choose ‘Close’. Then, direct students to run a software, such as MINITAB, and open the file using the software.

The .dat file is a text file using tab as the delimiter.
Make sure you go to the location where you save the data.

Make sure you choose the file type .dat, select the file: hand_size_100, then, open.
In the first part of the activity, students are asked to:

- Create scatter plots, obtain correlations, and fit models between (Hand_length and Height), and between (Hand_width and Height).
- Make a comparison to see which variable is a better predictor of height, and discuss some reasons behind their observation.
In the second part of the activity, students are asked to browse through the data and to see if there are ‘unusual’ data.

Some students may notice there are some missing cases, and some students may notice some very small hand_width. For this data, case 79 and case 81 are two ‘unusual cases whose hand_width are 4” and 5”, respectively.

Students are asked to discuss possible reasons.

These cases are then deleted, students are asked to reanalyze the data and compare the results with the first analysis. Students are the asked to discuss the impact of these ‘unusual’ cases.
Real Time Online Hands-on Activities

Assessment

The assessment materials are classified based on three categories:

**Based on Activities**

- Minitab instructions
- SPSS instructions

When analyzing data, one can use any technology that is available for the class. In the following, we provide some instructional materials for MINITAB and SPSS:

For more rigorous training on SPSS, go to the site:

- Online SPSS Training Workshop

If you do not have commercial statistical software, there is an online statistical analysis tool available: go to the site:

- Statcrunch Online Data Analysis Tools

In addition, ARTIST (Assessment Resource Tools for Improving Statistical Thinking) site consists of very extensive list of student learning outcomes assessment tools. Go to the ARTIST site:

- ARTIST (Assessment Resource Tools for Improving Statistical Thinking)

ARTIST provides tests and measurement tools to use in research studies and evaluation.
### Assessment Based on Activities

<table>
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- ARTIST ([Assessment Resource Tools for Improving Statistical Thinking](http://stat.cst.cmich.edu/statact/real_time/self_test/indexactivity.html))

ARTIST provides tests and measurement tools to use in research studies and evaluation projects as well as additional information, like a Q&A section, that may be useful.
Assessment Based on Topics

*note* some assessments are covered in more than one topic

Topics:

- Graphical Display
- Descriptive Statistics
- Sampling (Random Vs. Subjective)
- Correlation and Regression
- Probability Concepts
- Distribution (discrete, Binomial)
- Normal Curve
- Sampling Distribution of Sample Mean
- Confidence Intervals and Hypothesis testing

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- ARTIST (Assessment Resource Tools for Improving Statistical Thinking)

ARTIST provides tests and measurement tools to use in research studies and evaluation projects as well as additional information, like a Q&A section, that may be useful.
Assessment Based on Projects

The following projects is developed based the 'One minute exercise activity'.

- **Mid-term Project:** Applying descriptive and graphical techniques for analyzing the Exercise data.
- **Final Project:** Applying all any appropriate techniques learned from the class.

Suggestions for a Project:

- As a group project with 2-3 students per group
- As a two stage project report with a midterm project report incorporating descriptive and graphical techniques and with a final project report which adds to the midterm project incorporating inference techniques, such as hypothesis testing

Rubric for Project evaluation:

In addition, ARTIST (Assessment Resource Tools for Improving Statistical Thinking) site consists of very extensive list of student learning outcomes assessment tools. Go to the ARTIST site:

- ARTIST (Assessment Resource Tools for Improving Statistical Thinking)
Suggested Questions for Homework or Projects

Activity Hand_size: Is hand size a good predictor or height?

Questions for Key Concepts:

1. The following statement is statistically incorrect. Explain what is wrong. Student ratings of professors' teaching and colleagues' ratings of their research have a correlation of r=1.21. This shows that those professors who are good teachers are also good researchers.

2. Is there evidence that a relationship exists between moderate wine consumption (X) and number of deaths due to heart disease (Y) for developed countries? Data collected on 19 developed nations is summarized. Use this information to answer the remaining questions.

\[ X = \text{wine consumption (avg. # liters wine per person per year)} \]
\[ \text{Mean} = 3.03 \]
\[ \text{Standard Deviation (SD)} = 2.51 \]

\[ Y = \text{number of heart attack deaths per 100,000 people/year} \]
\[ \text{Mean} = 191.05 \]
\[ \text{SD} = 58.40 \]
\[ \text{Correlation} = -0.843 \]

(a) Interpret the value of the correlation in this setting.

(b) Assume a scatterplot shows a linear relationship. What other evidence do you have to suggest that it is ok to go ahead and fit a line to this data?

(c) Explain how you would verify, by calculation, that the slope of the best-fitting line for this situation is -22.97.