Statistical Literacy for Educators: Usability Study

Dmitrii Egorov
University of Hawaii at Manoa
degorov@hawaii.edu
https://degorov.wixsite.com/statsforeducators

Abstract: The role of data in many fields and areas of modern life is significant. Gathering, shaping, storing, and analyzing data is becoming a very important industry. This importance of data analysis implies that even people who are not employed in analytic positions would benefit from understanding at least basic concepts of data analysis. This fact increases demand in statistical literacy, especially for those who are dealing with data during their workflow. Educators, and especially teachers are among those who collect data from their students and might benefit from understanding the basic principles of statistics. This project aimed to develop and evaluate an online based resource where basic statistical concepts are paralleled with scenarios of their use in a classroom. The usability study explored ease of use of the website and satisfaction rate of the content presented on the website. The usability study confirmed the need in a resource introducing basic statistical concepts in a simple and highly approachable manner for those employed in the field of education. At the same time, it revealed that simplicity shouldn't be extreme, and the resource should take advantage of modern webtools, thus keeping a good balance between accessibility and functionality.

Introduction

It is hard to underestimate the role of data and needs in its collecting, storing and analysis in the modern world. In most cases, the manipulating and the data analysis is carried out by professional researchers, statisticians and data scientists. At the same time, it is believed that basic statistical literacy and ability to understand the results of statistical research would be beneficial for the educators whose primary professional responsibilities aren't directly related to data analysis and research (Gal, 2002). For example, teachers collect data getting test scores from their students. They could elicit some valuable insights from that data even without sophisticated statistical analysis (Pfannkuch, 2006; Makar & Confrey, 2002). In this case, they can inform decision makers and administration of various issues which can lead to further research on a higher level and, finally, to be a ground for some positive changes.

On the other hand, such knowledge of basic statistical concepts and skills of applying them would give a teacher more confidence about their curriculum and students' performance. There are several attempts to address those needs. For example, Classtime is introduced as "classrooms that complements in-class teaching with immediate

feedback on students' level of understanding" (Classtime, n.d.). One of the drawbacks of this tool is that it is not free. A six-week course "Analytics for classroom teachers" provided on EdX platform (Curtin, 2020) is possible time-consuming and oriented on policies employed in Australian school.

After understanding the benefits of statistical knowledge one of the main challenges is to scale the scope of concepts to be presented so that an instruction wouldn't be too much of a burden for the teacher during an ongoing semester. Another goal is to make situations for potentially beneficial use of statistics easily recognizable for persons without statistical background. In order to address these challenges, it was decided to develop a short online based module which includes explanation of basic concepts of descriptive statistics (such as mean, mode and median) and their graphical representation as well as scenarios where the teacher could apply those.

Literature Review

There are a lot of online resources introducing basic statistical concepts for beginners such as (Measures, n.d.), but the main problem of those is that they are rarely narrowed down to a certain field of statistical analysis. It might be hard for a beginner to extrapolate the given information to their working or everyday environment.

Aside from the EdX course "Analytics for classroom teachers", the researcher didn't find instructional modules in statistics designed specifically for educators. The course provides a broad context of educational policies; explains areas for applying analytical tools in planning lessons and course design, analyzing students' performance through descriptive, predictive and prescriptive statistics, and teachers' reflection; and introduces online services and platforms for each area for classroom teachers. As a very valuable source for those seeking Learning Management Systems or analytical tools, the course however ignores statistical literacy and focuses mostly on technical solutions.

At the same time, researchers noticed that there is a need in improving statistical literacy in teachers in general, rather than using ready solutions only. For example, reading boxplots and graphs and eliciting all valuable information from them might be problematic for some teachers (Pierce & Chick, 2013). As mentioned above, there are also multiple resources and online blogs aiming to explain statistics on different levels of complexity unrelated to the scenarios of use specific for a different professional field. To address these gaps, the researcher decided to implement a small website presenting basic statistical concepts and their applications, designed and adopted for a specified audience (namely educators).

The systematic design of instruction (Dick et al., 2009) is a practical framework which lets one create an instructional module as an iterative process going through several evaluation procedures. It is also important that the systematic design facilitates building a clear structure of instructional content, developing and applying assessment instruments, developing instructional strategies and materials.

ARCS model (Keller, 2008, 2010) was employed to support the effective domain of learning important for this study. The ARCS model allows maintaining and measuring a high level of motivation in learners through the use of attention, relevance, confidence, and satisfaction. A considerable part of the resource built for this study targeted the user's attention. Engaging videos and visuals were used for this purpose. Subsequently it turned to an explanation that the topic is important (relevance) and not too difficult to practice (confidence). It then proceeded with an approachable explanation of the main concepts and their application leading to user's satisfaction, which was later measured throughout the evaluation instruments.

Case-based learning (Boehrer & Linsky, 1990) was used throughout the instructional module. Case-based learning is especially a valuable strategy when there is a need to apply theoretical content in real-world scenarios. This is the case for the current study where the main focus is not on explaining the several basic theoretical concepts of descriptive statistics, but rather on understanding the benefits of their knowledge and the ways they can be employed in the classroom. Multiple studies suggest that using cases is beneficial over non case based techniques (Bonney, 2015; Krain, 2016).

Data collection instruments and usability testing were developed in accordance with the approach presented by Krug (2010) in order to elicit valuable information about interface flaws and user's experience on the website.

The report by the Department of Education conducted in 2009 (Means et al., 2009) provides a broad review of online learning studies, claiming the effectiveness of **online learning** compared to traditional forms of education.

Methodology

Research Questions. The research questions to be addressed include:

1. How easy was it for the participants to navigate through the materials on the website?
2. How useful were materials presented on the website?
3. How satisfied were participants with the way the statistical concepts and their application are presented on the website?
4. How did participants' attitude towards knowledge of statistics change after going through the website?

Purpose statement
The purpose of this study is to evaluate the ease of use, usefulness of the materials and the way they are presented on the website.

Content Analysis. The content for this module stayed on the very basic level of the statistical field. It includes such concepts as types of data (quantitative and qualitative), main chapters of statistics to give some sort of a background for the participants (descriptive and inferential statistics) and some basic concepts from descriptive statistics (mean, median, mode, standard deviation). One reason for this is that statistics might be difficult to learn especially when one speaks about practical implementation of statistical theory. The researcher wanted to make sure that the potential user would avoid cognitive overload on the stage of presenting some theory.

Another and even more important reason was that the focus is made on the possible application of those statistics. The main idea was to emphasize that even basic knowledge and understanding of statistics could lead to important insights about the data related to one's professional needs. This idea was planned to be implemented through a short set of scenarios where a fictional character demonstrates based on his or her experience how that knowledge can be useful. Later it was concluded that, before engaging users with the scenarios, the set of examples was a necessary stage. At this point, the set of scenarios was put on hold due to time limitations and is still to be created with next possible iterations of the website.
With that in mind, there were three principles intended to be crucial for the resource: simplicity, clarity, and approachability.
The media content and visuals used throughout the module were referring to the affective domain and aimed to counter the potential bias in learners about statistics as the mainly theoretical and abstract field of knowledge.

Participants. For the purposes of this study the participants were expected to meet several requirements. It was planned to look for participants among candidates employed in the educational system or getting a degree in education, having basic computer literacy, having a high school degree or higher, having heard of statistics, but possibly not familiar with specific concepts and how to apply them. In order to fulfill these requirements it was planned to recruit up to 12 participants majoring in the LTEC undergraduate or graduate program or related fields. The focus was supposed to be on those who are currently employed as high school teachers.

Evaluation Instruments. There were three evaluation instruments used throughout the study to evaluate the website usability issues and content satisfaction: pre-survey, usability study plan and protocol, post-survey. Both pre- and post surveys were created in Google forms. The **Pre-survey** was created to collect the participants' demographic data as well as their basic familiarity with statistical concepts (Appendix A).
Usability study plan and protocol contains a full description of the usability test procedure including introduction, final word and five usability tasks to be fulfilled by the participants during cognitive walkthrough (Appendix B).
Post-survey mainly aims to find out the participants' satisfaction with the website usability and its content (Appendix C). The Post-survey consists of 18 questions broken into four parts: Navigation and Visuals, Content Quality and Relevance, Usefulness, and Comments.

Project Design Strategies. To develop the resource to be evaluated throughout the usability test the researcher used Wix website builder. The design of the resource was aimed to be clear, focusing on main topics and avoiding cognitive overload and confusion in users. For this purpose it had been decided to have three big blocks on a landing page related to different content parts. The first block named "Learn why" contains motivational materials about using Statistics and Data Analysis. This element of the design is supported by Keller's ARCS model (Keller, 2008, 2010). Having a main purpose to engage potential users this page contains three embedded videos from YouTube showing and explaining how statistics might be important, fun, and tricky. The visual design of the page is less formal and strict than most others on the website. The goal was to create a more "eye-catching" appearance of the page.

The second block, "Learn What" contains short descriptions of several basic statistical concepts, such as types of data, descriptive statistics, inferential statistics, and then mean, median, mode. Explanations were designed to be short and clear. In order to support textual representation, several instructional videos were used. For this purpose the researcher used several videos from the YouTube channels "StatQuest with Josh Starmer" and Khan Academy. Namely, the topics of histograms (Starmer, 2017), measures of center (Khan Academy, 2011), and measures of spread (Khan Academy, 2010) were supported by the videos from above YouTube channels.

The third block "Learn how" presented textual representations of several scenarios for the potential application of theoretical concepts in the classroom for the purpose of basic analysis of learning parameters. This part turned out to be the most challenging both in terms of implementation and the revision of initially planned solutions in instructional design. All scenarios were planned to be unified by using a fictional character to make it more vivid. During the realization of previously planned concepts and ideas, the researcher realized that going from concepts to scenarios directly might lead to missing a very important stage, the stage with examples of how to extend theoretical concepts presented earlier in the conditions of the classroom. The examples turned out to be more theoretical than previously anticipated. An open question remains regarding whether this stage is sufficient for the main purposes of the instructional website or should it be a transitional stage to be extended further via more concrete scenarios; this question might be addressed during the usability study. Currently the "How" section contains descriptions of 5 situations of how statistics might be used with respect to classroom needs.
Situation 1: The means of two classes are the same.
Situation 2: Means are different for two groups of students.
Situation 3: Mean and Median are significantly different.
Situation 4: Mean and Median are different when your values are spread in a skewed manner.
Situation 5: What does it mean to grade on a curve.

The situations presented above are supposed to cover the most important examples of how to interpret statistics collected from classroom observations. The language used is intended to be clear, rather informal with occasional elements of humor. The visual palate

of the website should be light and undistracting with several underlined elements. Full website representations are shown in appendices (Appendix D). The graph on the landing page (Figure 1) was created in Google Ngram Viewer. It represents the frequency of the words "data", "analysis" and "intuition" from multiple printed sources and aims to depict metaphorically the former two dominating under the latter one. It doesn't require any action, the main goal is to attract the user's attention and create the right atmosphere before proceeding on the website.
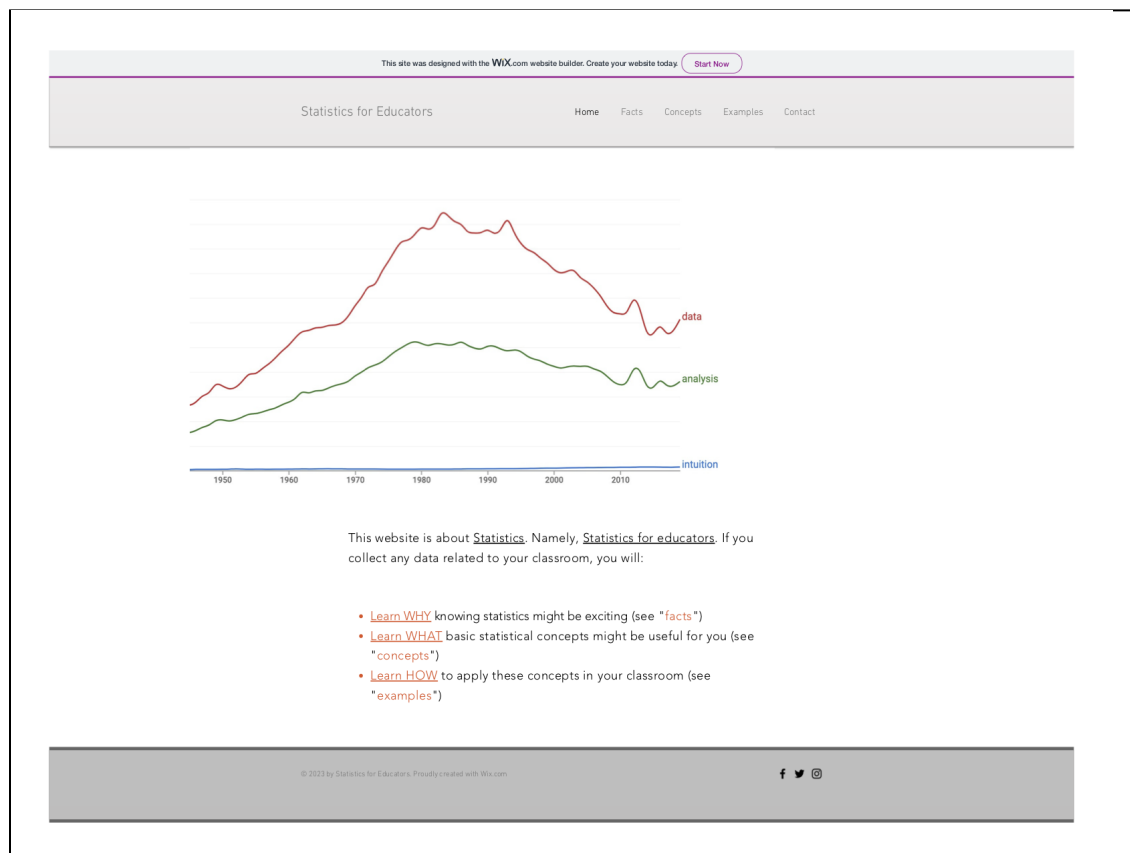
Figure 1. Image of statistics for educators home page

Procedures. To conduct a usability study based on the website, two CITI training certificates on human subjects' research and information privacy security were obtained by the investigator (Appendix E). All procedures started upon IRB approval.

To evaluate the website's ease of use, usefulness of the materials and the way they were presented on the website three rounds of remote usability testing were conducted via video platform Zoom. The number of participants in each round was 5, 5, and 2 respectively. Before the start of the usability testing all participants were asked to fill out the consent form (Appendix F) and short pre-survey collecting their demographic data and background knowledge of statistical concepts. Both the consent form and the link to the pre-survey were sent to each participant via email before the usability interview. After connecting via Zoom the participants were asked to share their screens and were informed that the session with their participation would be recorded.

During the usability session the participants were asked to perform five specific tasks aligned with the research questions of this study (Appendix B). Some tasks were designed to assess visuals and ease of use of the website, while others were targeted to estimate the usefulness of the content and its accessibility. The participants were asked to think out loud while performing the task. Time of the usability sessions varied between 25 and 45 minutes. Upon the completion of the five tasks, the participants were asked to fill out a post-survey. The goal of this survey was to collect information about the participants opinions, impressions of interacting with the website and its content. With prior permission from the participants their voices and computer screens were recorded with the use of the recording function on Zoom video conference. The recordings were stored in a password-protected laptop and reviewed by the investigator. The notes taken from this review were put on an observation sheet.
More detailed timeline for the project can be found in Appendix J.

Analysis and Results

All research questions were answered throughout the usability study. Regarding ease of navigation on the website (research question 1), all participants agreed that the website was easy to navigate. In terms of the usefulness of the content presented on the website (research question 2), all participants agreed that supporting videos and pictures were helpful, and most of them agreed that existing materials were sufficient. About participants' satisfaction with the way the content was presented (research question 3), most of the participants were positive about the simplicity of the materials and the way they were presented on the website. At the same time, the participants with a less developed background in Statistics liked an example-oriented approach. Regarding a change in attitude toward knowledge of statistics (research question 4), the answers to post-survey questions demonstrated clear positive dynamics in participants' views about statistics.

Pre-survey. For the stage of collecting data, 12 participants were recruited via email (6 female, 6 male). All of them had some relation to the educational system. The majority of the participants were employed in universities (9), only one in K-12 education and 2 in Data analysis for education organizations. The majority of the participants (10) had a background in statistics ranging from expert level to familiarity with basic concepts and analysis. The majority of the participants had positive views and opinions about statistics including its usefulness for everyday life and professional purposes. Generally, they viewed statistics as an interesting but challenging subject to master. The usability study and post-survey were intended to reveal how participants' interest in statistics and overall attitude changed after becoming familiar with the website.

Cognitive walkthrough. Throughout the usability session the investigator tried to understand some common features of user experience, user's impressions of the way content was presented and structured and spot any technical or conceptual flaws on the website. There were five tasks, two of which targeted assessing the layout and navigation, and the remaining three were aimed to understand the user's perception of the content including supporting and curated materials (illustrations, videos, linked articles). There

were two groups of participants: experts in statistics and novices both employed in the educational field. Some tasks related to the content were slightly adjusted in some cases, based on the participant's level in statistics. Thus, experts were asked to assess materials from the point of view of novices, while novices were asked to approximate how easy it would be for them to acquire statistical concepts presented on the website. There were no problems in terms of navigation on the website. Some contradictory feedback was received about the graph on the landing page. Some participants were slightly confused about its purpose. At the same time almost all participants figured out that it didn't require any action from their side and two participants correctly identified the message intended by the investigator. Although it was contradictory the investigator decided the graph met the expectations since it attracted user's attention which all participants confirmed when asked out loud.

Most of the participants were positive about the simplicity of the materials and the way they were presented on the website. The participants with less developed background in statistics liked an example-oriented approach in the explanation of theoretical concepts and examples. All participants agreed that supporting videos and pictures were helpful and in most of them agreed that existing materials were sufficient. One participant questioned the narrative structure of the explanations, while others were positive about it.

Improvements. All changes based on participants' suggestions were implemented upon completion of the first two rounds of the study. Most of them were accepted, due to their consistency with the researcher's intentions for the project. Those intentions were simplicity, clarity, and approachability. Thus, to improve simplicity and clarity of the resource, the spacing between paragraphs on the Concept page was adjusted. More importantly, participants' suggestions resulted in a rearrangement of situations with links and important words, which had sometimes appeared underlined, thereby confusing some of the participants.
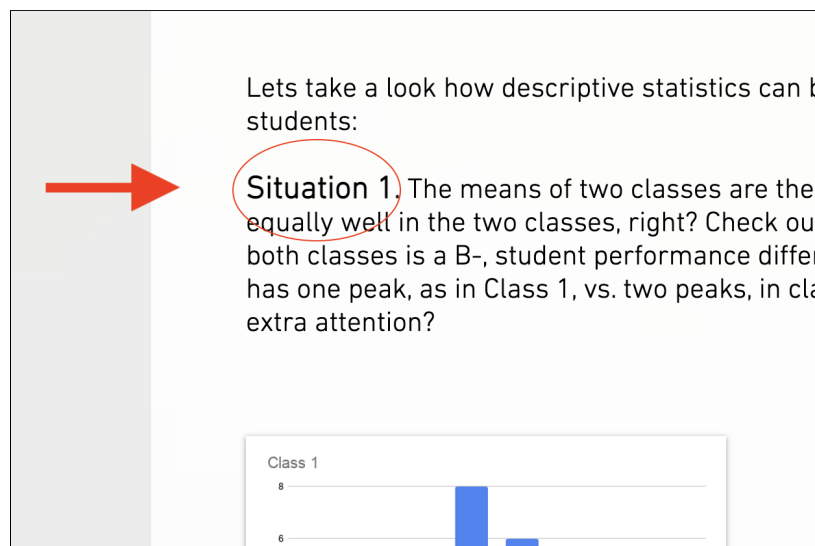

Figure 2. Titles and important words were marked other way than underlined

To address the approachability of the content, some definitions were rephrased as suggested on round 1 of the study (for example, the description of central tendency). On the other hand, based on one of the suggestions on round 2, the order of concepts in the text was aligned with subsequent titles.
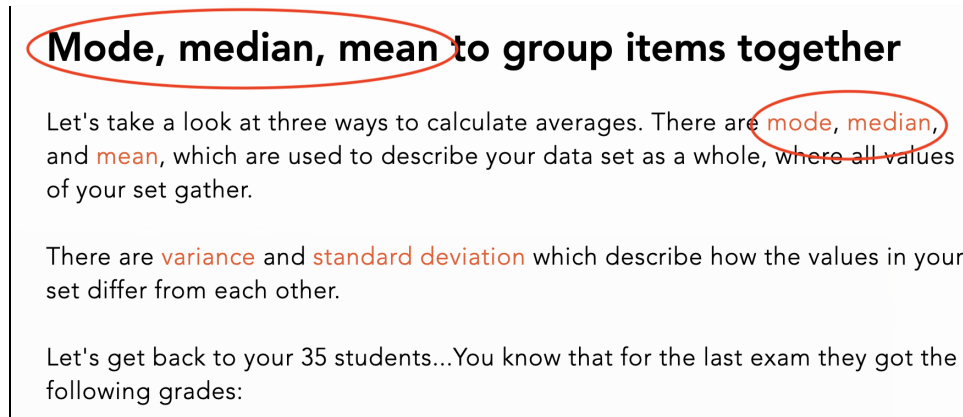

Figure 3. Order of the concepts in the text reflects the one in the title

Regarding round 3, the researcher received highly valuable ideas, some of which were accepted for implementation, but put aside due to time constraints. Specifically, it was recommended to create a set of scenarios based on a classroom routine to show how to use the concepts presented on the website. That was one of the researcher's initial ideas, which had not been implemented due to limitations of time and resources.

Post-survey. The post-survey contained 18 questions grouped into four parts: Navigation and Visuals, Content Quality and Relevance, Usefulness, Comments. First two parts mostly confirmed the general positive impression of the participants about navigation, layout and content quality revealed throughout the usability sessions. The third part of the questionnaire had retrospective questions to reveal how the participants' views and opinions changed before walking through the website and after. The participants were asked how useful statistics was, how interesting and engaging, and finally how easy it was before and after visiting the website. The last two statements used a 5-point Likert scale, from 1 "Strongly Disagree" to 5 "Strongly Agree". The results demonstrated clear positive dynamics in participants' views about statistics Thus, the number of participants who thought that statistics were useful both within their work and outside of it increased from 8 to 10 (it should be mentioned that nobody answered that statistics was not interesting).
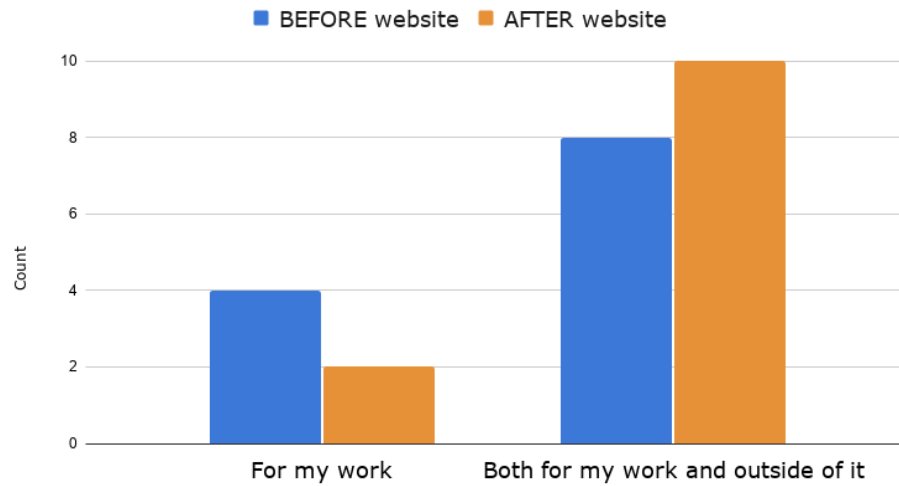
Figure 4. Participants' responses regarding potential uses of statistics

The more dramatic change was detected when the participants were asked to rate how easy statistics was on a scale from 1 to 5 (where 1 = strongly disagree, 5 = strongly agree): the 7 participants who chose 1 and 2 on the scale shifted to more positive ratings.
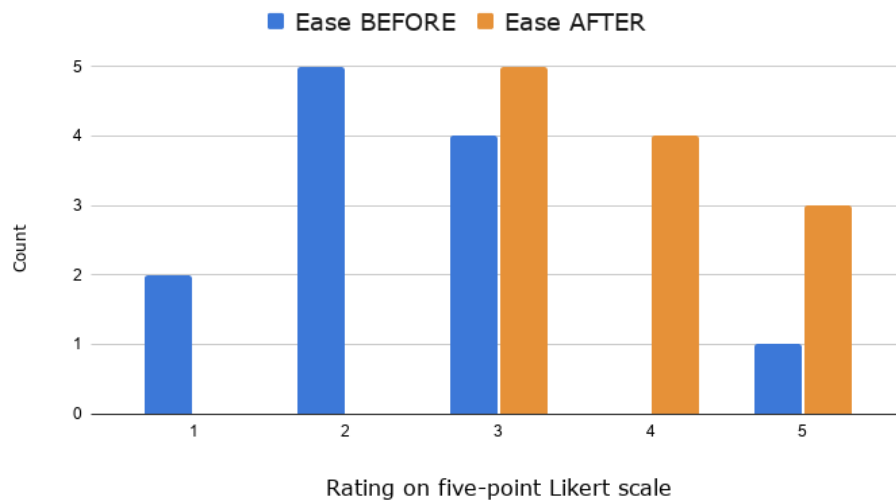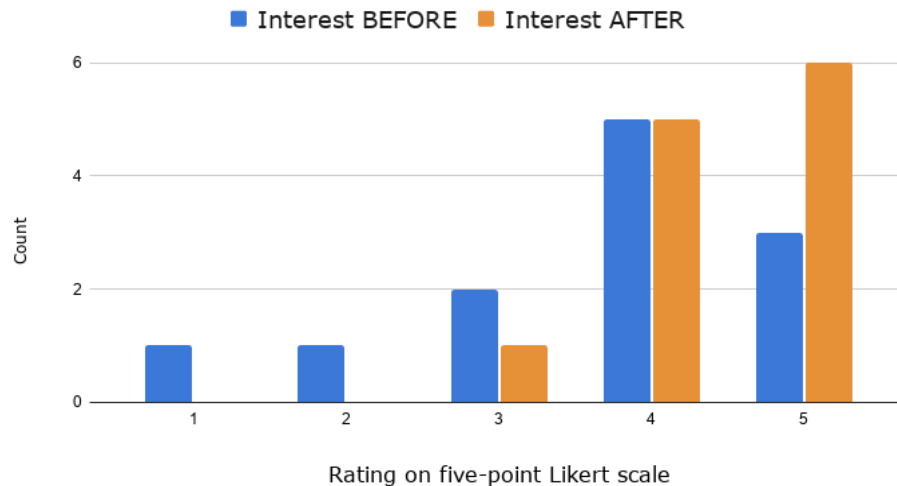

Figure 5. Participants' rating for ease of understanding statistics

At the same time, the post-survey detected highly increased interest in statistics among the participants.

Figure 6. Participants' self-rated interest in statistics

Discussion

The website built during this project aimed to test the idea of a specialized educational resource on statistics for an audience with specific imagined needs and characteristics. The main challenge throughout this project was that there has not yet been a concrete group of people or an organization the website was made for. On the one hand, the abstract nature of the project gave the investigator more freedom in elaborating ideas and design solutions. On the other hand, there is always a risk of overlooking the real needs of the hypothetical audience and creating a resource not required by actual representatives of its target audience. This factor made implementation easier than anticipated, but the stage of usability testing occurred to be particularly challenging due to the risk that the researcher failed to anticipate the needs of the audience. Representatives of the target audience declared for the resource as well as subject matter experts took part in the study, both providing valuable insights about possible ways to improve the user's experience as well as quality of the content. Overall, there was agreement about simplicity and clearness of the layout, and accessibility of the content. The organization of the content was questioned by some of the participants but generally worked well for the majority of them.

Some participants suggested more features on the website (for example, popping up windows with definitions or/and links), but the simplicity of the content and clearness of the website's layout was one of the main intended characteristics of the recourse. Since this idea was supported by the majority of the participants, it was decided to decline any interventions potentially complicating user experience, at least temporarily.

Based on the results of the usability study the investigator implemented some changes unifying links and underlined texts. The content of the website met the investigators expectations and demonstrated a high satisfaction rate of the participants. It should be mentioned that some opinions about the content were contradictory. Thus, an example-oriented approach in explanation of the concepts, chosen by the investigator on

purpose, was highly accepted by the majority of the participants, while a few of them preferred a more definition-oriented approach. Based on feedback from participants, it was concluded that the existing method of explanation meets the expectations of the target audience to a greater degree, and it was left unchanged.

Some major changes suggested throughout the study were accepted, but stayed to be addressed in further iterations of the project. Thus, it was decided that the website would benefit from implementing some sort of testing instruments, such as quizzes. Another valuable modification suggested during usability testing echoed the initial idea of the investigator: namely, using scenarios from classroom routines with a fictional character. That would be a useful and natural continuation of the example stage, but implementation of this was put aside due to time and resources constraints.

Conclusion

It is commonplace nowadays that collecting and analyzing data as well as understanding the statistical analysis carried out by others is an important skill for a broad range of specialists in multiple fields. Educators are among those specialists. Many of them would benefit from the ability to fulfill at least basic data analysis and proper understanding of its results and description. The growth of so-called big data and the popularity of data science caused the existence of multiple sources teaching how to perform statistical analysis. Among them, it is challenging for a beginner to identify not only a high quality resource, but one specific for a certain field and accessible to novices at the same time. The website built during this project aimed to test the idea of a specialized educational resource designed specifically for a certain audience based on its specific needs and characteristics.

The usability study conducted throughout the project confirmed the need in a resource introducing basic statistical concepts in a simple and highly approachable manner for those employed in the field of education. At the same time, it has to be taken into account that simplicity shouldn't be extreme, and the resource should take advantage of modern webtools, thus keeping a good balance between accessibility and functionality.

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List of Appendices

Appendix A: Pre-survey
Appendix B: Usability protocol
Appendix C: Post-survey
Appendix D: Website screenshots
Appendix E: CITI Training Certificates
Appendix F: Consent Forms
Appendix J: Timeline

Appendix A
Pre-survey

Pre-survey

* Required

1. Email address *

   _____

2. Age range *

   Mark only one oval.

   ( ) 18 - 25

   ( ) 26 - 35

   ( ) 36 - 45

   ( ) 46 - 55

   ( ) 56 - 65

3. Gender *

   _____

4. Occupation *

   Mark only one oval.

   ( ) K-12

   ( ) Community College or technical school

   ( ) University

   ( ) Data analysis

   ( ) Other

5. Background in Statistics *

Mark only one oval.

- ( ) I've heard of Statistics, but don't know how to apply it
- ( ) I am familiar with Statistics and can do basic analysis
- ( ) I am familiar with Statistics and usually understand when I am reading articles with statistical analysis
- ( ) I use Statistics often as part of my work routine

6. Statistics is an interesting field to learn about *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	( )	( )	( )	( )	( )	Strongly Agree

7. Statistics might be useful for something outside of your professional needs *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	( )	( )	( )	( )	( )	Strongly Agree

8. Statistics will help you be more efficient in your professional field *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	( )	( )	( )	( )	( )	Strongly Agree

9. Learning Statistics is easy *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Appendix B
Usability protocol

Technology Set-Up Checklist (Facilitator Computer)

1. Facilitator should set up his/her computer and attach all cords/peripherals - make sure to use a wired mouse
2. Plug in to a power outlet (don't trust the battery)
3. Make sure computer is connected to the Internet
4. Set up audio and test - headset test
   a. Ensure the microphone is working
   b. Ensure the volume is at a reasonable level
5. Login to Zoom account.
6. **Schedule a zoom meeting.**
7. **Send an invitation to the participant with the URL link to the scheduled meeting.**
8. Contact participant and ask if participant's computer is set up and participant is ready.

After Participant computer is set up:

9. Facilitator starts the Zoom meeting.
10. Facilitator joins the meeting.
11. Participants can run a test to see if microphone, video and share screen functions are working.

Technology Set-Up Checklist (Participant Computer)
12. Participant sets up computer and attach all cords/peripherals - make sure to use a wired mouse
13. Plug in to a power outlet (don't trust the battery)
14. Make sure computer is connected to the Internet
15. Set up audio and test - headset test
   a. Ensure the microphone is working
   b. Ensure the volume is at a reasonable level

16. Ensure that **Zoom** application is installed and open (this helps it to launch faster)
17. Await email invitation to join **Zoom** account and select "Join"
18. After joining, on the lower left of your screen be sure audio and video are active (if there's a red line through the microphone and video camera, select "Unmute" and "Start Video"
19. After the introduction, the facilitator will send the website URL over the chat function in zoom.

Facilitator Script

❏ ***Alert the participant that you will start recording, and select "Record"***

Hi, [insert participant's name]. My name is Dmitrii, and I'm going to be walking you through this session today.

Before we begin, I have some information for you, and I'm going to read it to make sure that I cover everything.

I am a graduate student at the Learning Design and Technology Program of University of Hawaii at Manoa. As my final project I built a website "Statistics for Educators" which you are going to see soon. I am asking people to try using the website to see whether it works as intended. Your participation is very important to complete this task and I very appreciate your help. The session should take about 20 minutes.

The first thing I want to make clear right away is that we're testing the *site*, not you. You can't do anything wrong here. In fact, this is probably the one place today where you don't have to worry about making mistakes.

As you use the site, I'm going to ask you as much as possible to try to think out loud: to say what you're looking at, what you're trying to do, and what you're thinking. This will be a big help to me.

Also, please don't worry that you're going to hurt my feelings. I am doing this to improve the site, so we need to hear your honest reactions.

If you have any questions as we go along, just ask them. I may not be able to answer them right away, since we're interested in how people do when they don't have someone who can help. But if you still have any questions when we're done I'll try to answer them then.

And if you need to take a break at any point, just let me know. Do you have any questions so far?

OK, great. We're done with the setup, and we can start testing out the site.

❏ ***Send participant URL for website to be evaluated:***

Use the chat feature of Zoom to send your participant the URL for the website to be evaluated.

❏ ***Ask participant to begin the screenshare:***

Please start Screenshare by clicking on the 'Share ' link on bottom of the window.

Very important! Please minimize the "Zoom" tab so that you can see the whole website!

❏ *Have participants do a narrative of the website's overall appearance three or four minutes, at most:*

Task 1:

I'm going to ask you to look at this page and tell me what you make of it: what strikes you about it, what you think this site does, and what you can do here. Just look around and do a little narrative. You can scroll if you want to, but don't click on anything yet. Also, how does layout look like in your opinion (colors, pictures, visuals overal)

❏ *Ask participant to complete a few specific tasks based off of their scenarios sheet:*

Thanks for doing that. You did a great job. Now I'm going to ask you to try doing some specific tasks. I'm going to read each one out loud. You should have received a copy of these in your email before this study.

I'm also going to ask you to do these tasks without using any search features. I'll learn a lot more about how well the site works that way. And again, as much as possible, it will help me if you can try to think out loud as you go along.

Allow the user to proceed from one task to the next until you don't feel like it's producing any value or the user becomes very frustrated. Repeat for each task or until time runs out.

Scenario for Usability Study

You are an educator employed in a school/university/training unit where you have the opportunity to collect data about your students in order to facilitate or/and improve learning experience for your students. The data usually include demographic information, information about your students' performance, time you spend on different tasks and related data.

One of your colleagues mentioned that there is a website which can be helpful if you would like to use some Statistics to improve your teaching experience based on the data you can collect routinely.

With that scenario in mind, here are some tasks for you:

Tasks 2-5:
- Please, go through the description provided on the bottom of the landing page. Then, please take a look at the upper menu. Do you think those links provide different information? Or are those the same?

- Navigate to the "Facts" page. What do you think? What is your overall impression? Do you think that the questions covered by the videos are enough to engage you with Statistics?

- Navigate to the "Concepts" page. What do you think? Please, try to read at least some of the content on the page. Would you like some more videos to explain the theoretical concepts? Do you need videos at all to support descriptions?

- Navigate to the "Examples" page. What do you think of images? Are they clear? Do you think they are helpful? Do they clarify examples for you?

Thanks, that was very helpful.

❏ ***Request from the participant that they end their screenshare by clicking on the "Stop Share" button on the top of the window.***
❏ ***Ask the observers' questions (if time permits).***

We are done with the main questions, but I have a few more general questions to ask you.

Note: *If you ask yes/no, true-false, and ranking follow-up questions, be sure to follow up with questions about WHY. This is because design teams will ask, "Well, what was the cause? What exactly were they thinking when they answered this? How should the product design respond to this? Give us something we can use!"*

1. On a scale of 1 to 5, with 1 representing very difficult and 5 representing very easy, how would you rate your experience during today's testing?

2. After participating in this study, would you recommend this website to any of your friends? Why?

That's the last question, Do you have any questions for me, now that we're done?

Please go ahead and stop screen sharing now.

I want to thank you for your time and willingness to be a participant in this study.

❑   ***Stop the Zoom recording by clicking on the button labeled, "Record."***

After the Session:

1. Tech group ensures that the mp4 file is saved where it can be found
2. Quickly scrub through the video to ensure the integrity of the audio and video
3. Upload the mp4 file to the group's team drive.

Appendix C
Post-survey

Post-survey

* Required

1. Email address *

_____

Navigation and Visuals

2. The website was easy to navigate *

   Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

3. The design of the website was visually pleasing *

   Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Content Quality and Relevance

4. Theoretical concepts were described clearly *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	( )	( )	( )	( )	( )	Strongly Agree

5. Videos to explain theoretical concepts were helpful *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	( )	( )	( )	( )	( )	Strongly Agree

6. The examples on the page "Examples" were described clearly *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	( )	( )	( )	( )	( )	Strongly Agree

7. Illustrations on the page "Examples" were helpful *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	( )	( )	( )	( )	( )	Strongly Agree

8. The theoretical concepts presented were relevant to the tasks and responsibilities I have in my work *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

9. The examples presented were close to real situations I have experienced or might experience in my work *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Usefulness

10. BEFORE going through the website I thought that Statistics might be useful: *

Mark only one oval.

◯ For my work

◯ For something outside of my work

◯ Both for my work and outside of it

◯ Not useful at all

11. AFTER going through the website I thought that Statistics might be useful: *

Mark only one oval.

- ⬭ For my work
- ⬭ For something outside of my work
- ⬭ Both for my work and outside of it
- ⬭ Not useful at all

12. BEFORE going through the website, Statistics seemed interesting and engaging for you: *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	⬭	⬭	⬭	⬭	⬭	Strongly Agree

13. AFTER going through the website, Statistics seems interesting and engaging for you: *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	⬭	⬭	⬭	⬭	⬭	Strongly Agree

14. BEFORE going through the website, it seemed that learning Statistics is easy: *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	⬭	⬭	⬭	⬭	⬭	Strongly Agree

15.   AFTER going through the website, it seems that learning Statistics is easy: *

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Comments

16.   What did you like the best about the website? *

_____

_____

_____

_____

_____

17.   What did you like the least about the website? *

_____

_____

_____

_____

_____

18.   Is there anything you would like to be added to the resource like this? *

_____

_____

_____

_____

_____

19.   Is there anything you would change on the website to improve it? *

_____

_____

_____

_____

_____

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Google Forms

Appendix D
Website's screenshots
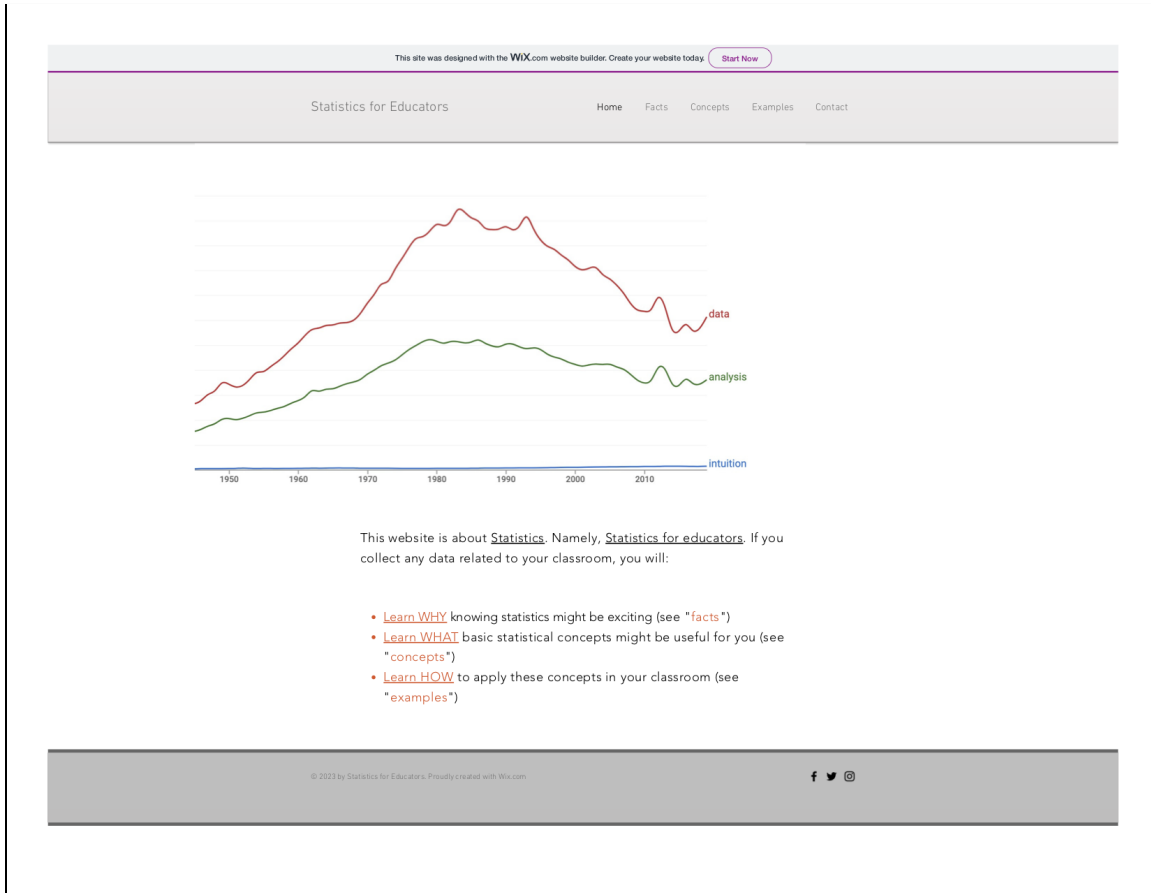
This site was designed with the **WiX**.com website builder. Create your website today. Start Now

Statistics for Educators

Home **Facts** Concepts Examples Contact

Let's look into WHY it is worth it.

Statistics is <u>important</u>, <u>fun</u>, <u>engaging</u>, <u>tricky</u>...
You don't believe it, huh?

It might be important...

Why you should love statistics | Alan Smith

▶

Statistics Is Interesting - No, Seriously!

▶

Sometimes it is fun...

And of course a bit tricky...

How statistics can be misleading - Mark Liddell

▶

Let's take a look at important <u>statistical concepts</u> to equip you with solid analytical tools...

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Statistics for Educators   Home   Facts   Concepts   Examples   Contact

Let's look WHAT basic concepts you should learn first
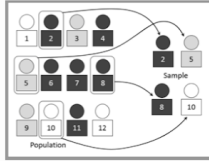
Let's suppose you have 35 students in your class. Each of them is a little different when we look at their performance, behavior, and some other features important in the classroom. Is there any way to see how different your students are?

Statistics allows one to organize their data, both numerical (numbers) and categorical, and elicit valuable insights based on that data.

Two types of Statistics

There are two main subfields in Statistics: descriptive and inferential.

Descriptive statistics aims to describe the whole population. But what if it is too big and unavailable? Then you could use just part of the whole population (sample) in order to get insights about it! And that's what Inferential statistics does.

Isn't it exciting?!

But even descriptive statistics gives one very significant piece of information about the data.

We will start with descriptive statistics and let's hope that it will be enough to continue studying it and even go further to inferential statistics.

Let's look at the most important concepts of descriptive statistics.

Mean, median, mode to group items together

There are mean, median, and mode, which are used to describe your data set as a whole, where all values of your set gather.

There are variance and standard deviation which describe how the values in your set differ from each other.
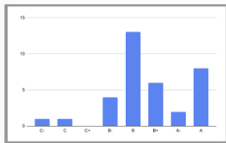
Let's get back to your 35 students...You know that for the last exam they got the following grades:

A: 8 students
A-: 2 students
B+: 6 students
B: 13 students
B-: 4 students
C: 1 student
C-: 1 student

Here you can see that majority of the students got B, and thus B is the Mode of your data set (the category representing the majority of the values).

4 is the Median of your data set. If you look at one half of the values (50%) they are less than 4 and another half (50%) are greater than 4.

Here we go. Now you are able to build a bar chart with you data. It would look like this:

Please, check out this video by Josh Starmer to learn more about histograms.

StatQuest: Histograms, Clearly Explained
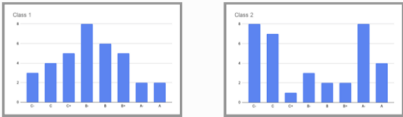
Statistics for Educators   Home   Facts   Concepts   **Examples**   Contact

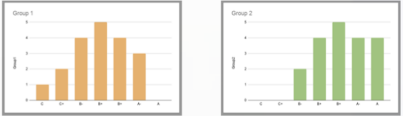## Let's look into HOW to use the concepts learned with typical situations and scenarios

In an ideal world the mean, median, and mode of your data set will be equal and all histograms will look like perfectly shaped bell, but in a real world...

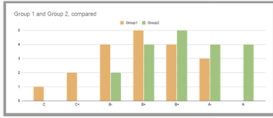Lets take a look how descriptive statistics can be used to compare two groups of students:

Situation 1. The means of two classes are the same. That suggests that the students did equally well in the two classes, right? Check out the data. Even though the mean grade in both classes is a B-, student performance differs a lot. What does it mean when the data has one peak, as in Class 1, vs. two peaks, in class 2? Which group of students needs extra attention?
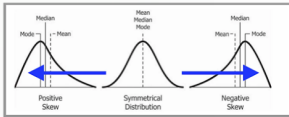
Situation 2. Means are different for two groups of students. Imagine you split your students into groups based on some demographic variable (age, sex, etc.) and the two groups have different means. Does that mean that the students in the higher-scoring group always perform better than students in the other group?

Not necessarily: it is likely that the distributions of the two student groups still overlap, meaning that many of the students in the lower-scoring group still outperform some students in the higher-scoring group. Make decisions accordingly.

Situation 3. As was mentioned, in an ideal world the mean, mode and median are equal (or at least close to each other in a less ideal world). But what if the mean and median are significantly different? It means that there are outliers that distort the mean. If it is the case, the mean should not be used to represent the average of your class performance. Rely on the median instead.

Situation 4. Another situation when the mean and median are different is when your values are spread in a skewed manner. What does it mean? It means that enormously large amount of your students performed either poorly or good. Looks like a reason to think twice about your students or the test you created for them.

Appendix E
CITI Training Certificates

Completion Date   01-Apr-2019
Expiration Date   31-Mar-2022
Record ID   31134942

This is to certify that:

Dmitrii Egorov

Has completed the following CITI Program course:

Information Privacy Security (IPS)   (Curriculum Group)
Exempt Researchers and Key Personnel IPS   (Course Learner Group)
1 - Basic Course   (Stage)

Under requirements set by:

University of Hawaii

Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?w1b717379-f5af-44d1-ac7d-af0fa931a430-31134942

CITI PROGRAM

Completion Date 01-Apr-2019
Expiration Date 31-Mar-2022
Record ID   31134943

This is to certify that:

Dmitrii Egorov

Has completed the following CITI Program course:

Human Subjects Research (HSR)   (Curriculum Group)
Exempt Researchers and Key Personnel   (Course Learner Group)
1 - Basic Course   (Stage)

Under requirements set by:

University of Hawaii

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?w951f5d7b-7a98-49f0-9da3-cd0001fe056c-31134943

Appendix F
University of Hawaii Consent to Participate in Research Projects

University of Hawai'i
Consent to Participate in a Research Project
Dmitrii Egorov, Principal Investigator
Project title: Statistical Literacy for Educators. Usability study of the online-based resource for educators

Aloha! My name is Dmitrii Egorov and you are invited to take part in a research study. I am a graduate student at the University of Hawai'i at Mānoa in the Department of Education. As part of the requirements for earning my graduate degree, I am doing a research project.

What am I being asked to do?
If you participate in this project, I will meet with you for a cognitive walk through session via Zoom application at a time convenient for you.

Taking part in this study is your choice.
Your participation in this project is completely voluntary. You may stop participating at any time. If you stop being in the study, there will be no penalty or loss to you.

Why is this study being done?
The purpose of my study is to evaluate the ease of use, usefulness of the materials and the way they are presented on the website. containing presentation explanations of several basic concepts of descriptive statistics (mean, median, mode, types of data) and scenarios of their use in a classroom or to elicit valuable insights about students' performance.

What will happen if I decide to take part in this study?
The interview (cognitive walk through) will consist of 5 tasks to be performed on the website. It will take 30 to 45 minutes.
The interview questions will include questions like, "Was the career counseling office able to offer insight in obtaining work, or further training in your career choice? If so, how so?" "What advice or tips did the career counselor give you that you would not have thought of yourself?"

Only you and I will be present during the interview. With your permission, I will record the screen of your desktop or laptop and your voice while performing the tasks, so that I can later transcribe the interview and analyze the responses. You will be one of about 12 people I will interview for this study.

What are the risks and benefits of taking part in this study?
I believe there is little risk to you for participating in this research project. You may become stressed or uncomfortable fulfilling any of the usability tasks or thinking out loud during the usability session. If you do become stressed or uncomfortable, you can skip the task or take a break. You can also stop the session, or you can withdraw from the project altogether.

There will be no direct benefit to you for participating in this study. The results of this project may help improve the Career Development and Counseling program to benefit future students.

Privacy and Confidentiality:
I will keep all study data secure encrypted on a password protected computer. Only my University of Hawai'i advisor and I will have access to the information. Other agencies that have legal permission have the right to review research records. The University of Hawai'i Human Studies Program has the right to review research records for this study.

After I write a copy of the interviews, I will erase or destroy the audio-recordings. When I report the results of my research project, I will not use your name. I will not use any other

0

Consent Form – version ___(insert version #)

University of Hawai'i
Consent to Participate in a Research Project
Dmitrii Egorov, Principal Investigator

Project title: Statistical Literacy for Educators. Usability study of the online-based resource for educators

personal identifying information that can identify you. I will use pseudonyms (fake names) and report my findings in a way that protects your privacy and confidentiality to the extent allowed by law.

Compensation:
You will receive a $5 gift certificate to either Starbucks or Jamba Juice for your time and effort in participating in this research project.

Future Research Studies:
Even after removing identifiers, the data from this study will not be used or distributed for future research studies.

Questions:
If you have any questions about this study, please call or email me at [(339)-707-5970 & degorov@hawaii.edu]. You may also contact my advisor, Dr. Catherine Fulford, at [(808)-927-8009 & fulford@hawaii.edu]. You may contact the UH Human Studies Program at 808.956.5007 or uhirb@hawaii.edu. to discuss problems, concerns and questions; obtain information; or offer input with an informed individual who is unaffiliated with the specific research protocol. Please visit http://go.hawaii.edu/jRd for more information on your rights as a research participant.

If you agree to participate in this project, please sign and date this signature page and return it to: Dmitrii Egorov (339-707-5970, degorov@hawaii.edu)

Keep a copy of the informed consent for your records and reference.

Signature(s) for Consent:

I give permission to join the research project entitled, "*Statistical Literacy for Educators. Usability study of the online-based resource for educators.*"

Please initial next to either "Yes" or "No" to the following:

_____ Yes   _____ No   I consent to be audio-recorded for the interview portion of this research.

_____ Yes   _____ No   I consent to having my screen video-recorded for the interview portion of this research.

Name of Participant (Print): _____

Participant's Signature: _____

Signature of the Person Obtaining Consent: _____

Date: _____

1

Consent Form – version ___(insert version #)

Appendix J
TimeLine

Date	Task
2020	
October	• Begin planning project development • Start project development
November	• Develop the website prototype • Finalise content for the website
December	• Finish first version of the website • Finalise IRB submission • Start creating data collecting tools
2021	
January	• Submit IRB application • Finalise data collecting tools: pre-survey, usability protocol and usability tasks, post-survey
February	• Start usability interviews (round 1)
March	• Continue usability interviews (rounds 1, 2, and 3) • Implement changes accepted upon usability interviews from round 1 and 2 • Analyse data
April	• Create TCC presentation slides
May	• Complete final paper