

CS 4712 User Interface Engineering

MODULE_7 – TOPICS

Measurements, Data Collection, and Analysis

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7.1 - Introduction and Background

Producing meaningful data collection is the key to producing meaningful data research. In other words, the research done by a sample of data cannot be meaningful unless the sample of data is meaningful in itself. It is important for the researcher to know how a particular set of data can be meaningful and how it can contribute to their research (Becker, H. 2019). It is also necessary to study different observation methods to collect data. We will discuss interviews and how they can quickly and directly produce meaningful data for research. We will also discuss the importance of using mixed methods of collecting data, and how it can be key in producing the most meaningful data. We will discuss the difference between research that is quantitative and research that is qualitative. Lastly, we will conclude with the best way to display the results and findings of a research topic.

Collecting and observing data can be done in a variety of different ways, but mainly through observational research, naturalistic observation, and controlled observation (Becker, H. 2019). Interviews are one method of collecting data which allow the interviewer and the interviewee to be face-to-face. Interviews can be highly structured, to ensure all participants undergo the same study, or interviews can be unstructured and made to fit the current situation. Questionnaires are a way of collecting data without the presence of the researcher. Questions are usually written beforehand and handed out to each participant in the study. Data of all participants is usually analyzed after all participants have concluded the study. We will also discuss the differences between quantitative and qualitative data, and how each type of data can be meaningful for different types of methods of research.

7.2 – Observation Methods and Technologies

Observational methods of research include observing the participants in a study without disturbing the environment in any way. In many forms of practice, the participants do not even know they are being studied. Based on the nature of the subject being studied, there are three types of observational research: naturalistic observation, participant observation, and controlled observation.

Naturalistic observation refers to observing participants in their most natural setting (Cherry, K 2019). The observer needs to be careful to not disturb the habitat of the participants in the study. Naturalistic observations are the best observations to create qualitative data, or data that is very meaningful to the research at hand. One advantage of naturalistic observation is that it allows researchers to conduct experiments without violating any moral or ethical concerns (Cherry, K. 2019). Another great advantage of naturalistic observations is that they help validate certain types of research. It is one thing to hypothesize a finding, but it is a completely other thing to observe those findings. However, the downside of naturalistic observation is that it is hard to replicate, which leads to a lack of quantitative research. Another major downside is that observations usually happen at a small scale, and are not truly representative of a larger population of individuals. Furthermore, people may behave differently when they know they are being watched, which may or may not be known to the researcher at hand. The last major downside is that it can be hard to determine the exact cause behind behavior in some individuals (Cherry, K. 2019).

The most common type of data collection method in naturalistic observation is tally marks (Cherry, K. 2019). The researchers will write down the behaviors that they find during their observation, and then create a tally for how many times they observe that specific behavior. If ethical, an observer may record a video or audio tape in order to re-examine his subjects at a later date. The observer will then take all of their notes during the observation, and then discern behavior patterns observed during the experiment.

During naturalistic observation, an observer may use time sampling or situational sampling. Time sampling is described as something that “involves taking samples at different intervals of time, which may be random or systematic.” Situational sampling has been noted as “observing a behavior in a variety of different situations and settings.” During the experiment, it is important for the researcher to know the different methods of sampling, in order for them to have the most accurate means of recording their data. The most widely-known example of naturalistic observation is Charles Darwin aboard the HMS Beagle. During eighteen months, Charles Darwin sailed along the coast of South America on a Navy ship and observed what scientists call Natural Selection. (Cherry, K. 2019)

The second method of observational research is participant observation. In this method, the observer intervenes in the environment of the participants in some way. The observer can intervene in two ways: overt or covert. In an overt manner, the observer reveals himself to the participants and explains the observer is there to collect data for research. This can be a great way to collect research that is otherwise rare to reproduce; however, it can also be a bad method of collection because a lot of occurrences can only occur naturally (Becker, H. 2019). The second method of participant observation is being covert. In this manner, the observer is disguised as a participant of the study, which allows the observer to gain hands-on experience for their research. Covert participation is obviously the better method of study; however, it is usually far more difficult to execute correctly compared to overt participation.

Controlled observation is the last method of observational research that we will discuss. Controlled observation is defined as the observational method “carried out under controlled, arranged conditions, often in a laboratory setting” (Becker, H. 2019). In this method of observation, a controlled stimulus is introduced to each participant in the study and the observer reports the differences in each participant. These studies are usually the least time-consuming of the three observational methods and can easily accommodate a larger sample size. The main disadvantage of this observational method is that the participants are not acting in their natural setting. Participants tend to behave differently when they know they are being watched by a researcher and other participants. Having participants acting outside of their natural habit can produce some easy (but often fruitless) research data.

7.3 - Questionnaires Design and Implementation

Questionnaires are a series of questions that are prepared beforehand to the participant. There are several main advantages and disadvantages of using questionnaires. One of the main advantages is being able to have several participants at once taking the survey. This allows the researcher to gather data much quicker than other observation methods such as interviews. Another main advantage is being able to interview people from all parts of the world all at the same time. An interview can be placed online, and participants from all parts of the world can complete the survey all at once. Another great advantage are more flexible time frames to gather data. The researcher can prepare the questions beforehand, and the questions can be answered by the participant in any given time frame.

The main disadvantage of questionnaires lies within the integrity of the participants. A participant may not take a questionnaire as seriously as an interview. In addition, it's possible for a participant to have someone take the questionnaire for them, which will skew the data for the researcher. It can also be difficult for some participants to answer the questionnaire questions because the researcher is not there to clarify any ambiguities (Preece, J. 2015). Another disadvantage of using questionnaires as a form of research is that the answers are fixed. When the questionnaire is prepared, the researcher needs to come up with answers for the participants to select. Sometimes participants are limited to answers that do not accurately reflect what the participants would like to answer. If the answer is a scale of some sort, the accuracy of the questionnaire depends on how big the scale is. Too big of an answer selection can lead to participant anxiety, while too narrow of a selection can lead to unreliable data.

Questionnaires should be implemented in a way that produces meaningful data for the researcher. These questions are then given to the participant (either physical or online) for them to answer. Before any questions are made for the questionnaire, it is important for the researcher to understand the audience he or she is questioning. For instance, if the researcher wanted to know how many miles people drive on a daily basis, then questioning individuals under the age of sixteen would be a fruitless endeavor. Furthermore, asking participants over the age of eighty how many miles they drive on a daily basis would also be a fruitless endeavor. Demographic information such as gender, location, age, and place of birth are among the most common questions asked at the beginning of each survey (Preece, J. 2015). It is great for the researcher to know the geographical information of their participants before drawing any meaningful conclusions about the data from their survey. For instance, participants who drive in New York City would probably drive much less than participants in the Midwestern United States.

In order for a questionnaire to contain meaningful data, one must carefully consider the method in which the questionnaire is being administered. Questionnaires need to be implemented in a way that allows all participants to return the survey with a reasonable response rate (Preece, J. 2015). Having a reasonable response rate allows for all data on the survey to be calculated and weighed for all participants against the survey group as a whole. When participants do not answer a question or do not answer a question accurately, it can greatly skew the results of the survey. It is more common for smaller sample sizes of participants to have a higher response rate on surveys. With larger groups of participants, the response rate generally decreases (Preece, J. 2015). When sampling a larger group or population, it is generally more common to use the Internet. Using the Internet can reach participants in several parts of the world simultaneously, and the results can be sent back to the researcher for data compilation. Surveys also can have built-in survey statistics, which allow for the survey data to be compiled while the results of the survey are being sent in by the participants. Decorating a survey to make it more appealing to the participant can also help improve accurate results from the survey (Preece, J. 2015). Web-based questionnaires can include “check boxes, radio buttons, pop ups and pull down menus” to make them more attractive. Web-based questionnaires should include the following steps:

- 1) The questionnaire needs to be error-free and be able to assist the participant in the event that they need it.
- 2) Information from each participant needs to be captured and stored confidentially, away from the view of anyone except the researcher. Using IP methods are among the most convenient methods to accomplish this; however, keep in mind that different people may use different computers (or several people may use the same computer) to complete the information on the survey.

- 3) Be sure to keep track of the data as it is being sent back to the researcher. This will help the researcher keep track of data trends within the research. Also, there is a chance that the data will be lost or corrupted, so it would be in the best interest of the researcher to keep track of data progression.

The different types of answers in a questionnaire may also affect the way in which the data from the questionnaire is compiled. Questions that are multiple choice or true/false can be quickly compiled by the questionnaire form and sent instantly to the researcher for data observation (Becker, H. 2019). However, some questions, such as short-answer, cannot be quickly compressed by the researcher and need to be read first before any meaningful conclusion can be stated. Because of this, it is important for the researcher to know what types of questions are asked of participants, and it is also important to make sure all types of questions are considered and read-over in a survey before any meaningful conclusions are made.

7.4 – Interview Techniques and Practices

Interviews are more commonly thought of as “a conversation with a purpose” (Becker, H. 2019). Interviews can be conducted in a variety of different ways, but the flow of the interview and how the interview is conducted depends on the purpose of the interview. There are three main types of interviews: structured, unstructured, and group interviews. The type of interview can depend on the situation and how often the interviewer is imposing on the situation.

Group interviews are meant to involve a large amount of people and have the least amount of interaction from the interviewer. A group interview is a form of screening multiple participants at the same time. In a group interview the interviewer can observe how participants choose to stand out amongst other participants in the interview. Along with this, the interviewer can observe some key skills, such as how participants decide to work together to figure out a problem. These types of interviews work well when interaction with others is essential to understanding a topic. From a group interview, the interviewer can gain insight from the interaction amongst the participants.

Unstructured interviews are the most common type of interviews, and usually involve the least amount of control by the interviewer. In this method of interview, the interviewer asks questions, and the answers are generally open ended and can lead to a different set of undetermined questions. For instance, imagine the interviewee saying somewhere along the interview that he works at a five-star restaurant in Tokyo. The interviewer may become interested and ask questions that they didn't plan to ask beforehand such as: “What is it like to live in Tokyo” or “What is it like to work for a five-star restaurant?” Despite the ability to ask unrelated questions, an interviewer does need some sort of structure in the interview beforehand to make sure all of the topics of the interview are covered. Unstructured interviews can go on for a very long period of time and generally have the most depth compared to other interview methods. Unstructured interviews can also go for the shortest amount of time. For instance, answering “no” or “not applicable” for a series of questions can make the interview go along very quickly and have absolutely no depth whatsoever. Because of the varying length of unstructured interviews, data obtained from them can be difficult to analyze (Becker, H. 2019). There may be some interviews that have a lot of information gained from them, and some interviews with no information gained from them. However when accessing information from a large amount of participants, it is important for the interviewer and researcher to know that it is always best to obtain as much data from the widest range of participants possible. This is to ensure that the data used in the research isn't skewed towards one specific person's idea or opinion.

The best way to analyze consistent data amongst a wide variety of participants is to use structured interviews. In a structured interview, questions are standardized and the same across all participants in the study. This is to ensure consistent interview length and to ensure consistent interview data across all participants. Structured interviews often include definite answers to questions, and the questions are usually not open-ended. If the answer is not available for a participant in the interview, then the “none” or “not applicable” option is usually available. For example, a closed-ended question in a structured interview can be something along the lines of “Which website do you visit the most?” or “How many times per week do you eat fast food?” Furthermore, structured interviews have the possibility of data misrepresentation, because often participants rush through the interview when they know the goal of the interview (Becker, H. 2019). For example, Youtube will often place ads in front of a video before it plays, and users will often select whichever option is quickest so they can get to their video. A rushed interview from the participant can only increase the chance of errors in the compressed data research.

Semi-structured interviews usually involve a mix of both closed- and open-ended questions. An interviewer usually starts with questions that they plan to ask the participant, but is allowed ample time within the interview to ask the participant to elaborate on some of their answers. For instance, a structured question may be asked first, such as “What type of music do you like?” and then be followed up with “What is your favorite rock metal band?” as part of the unstructured interview process. When asking questions based on the participants’ responses, it is important to allow the participant ample time to answer the questions asked. Questions such as “Is there anything else you would like to say?” may possibly be asked at the end of the interview to extend the allotted interview time.

Focus groups are another very common way of interviewing participants. Focus groups generally consist of one interviewer and a group of several people chosen to represent a much larger population. To represent the larger population, focus groups are generally a mix of ethnicities, genders, ages, and cultural backgrounds. The main benefit of using focus groups is that they allow for more sensitive issues to be addressed that mainly affect the population as a whole, rather than the individual (Preece, J. 2015). It is imperative that the focus group is acceptable to all participants and allows everyone in the focus group to hear and be heard. Preset agendas are usually created before the focus group meets and are there to guide the focus group to a conclusion without discussion straying off-topic. The facilitator usually will ask quiet people to speak, and make sure that the dominant people in the discussion don’t take up everyone else’s time. Focus group meetings may or may not be recorded, depending on the focus of the group meeting.

Before starting the interview, there are several key things to note. It is important to know who you are interviewing, so you can dress, act, and speak in a manner that will be familiar to the participant (Preece, J. 2015). This is especially important with children, the elderly, and terminally ill patients. During the interview it is important for the interviewee to listen more than talk; here are some suggested steps:

- 1) The interviewer needs to introduce themselves to the participant first, and explain why they are conducting the interview.
- 2) Easy questions, such as demographics, come first in order to “warm up” the participant to the harder questions that generally come later.
- 3) The more probing questions should come later in the interview.
- 4) Use cool-off periods to take a break between the harder questions and to relieve interview tension.
- 5) Always be sure to close the interview by thanking the participants.

Due to a rise in the Internet's popularity, face-to-face interviews and focus groups are becoming far more uncommon, especially when the participants live in different geographical regions. However, there are a few advantages of conducting interviews over the Internet. Participants in their own environments are generally more relaxed and less likely to make an error in the interview process. Because of this, when participating in interviews over sensitive topics, participants are more likely to give a correct answer when in their own environment rather than in a foreign room with unknown participants (Preece, J. 2015).

7.5 - Eclectic and Mixed Measurement Approaches

With the wide amount of information in this day and age, the necessity for a larger range of approaches in order to effectively measure and explain the effects of data is imperative. Mixed measurement can be defined as an approach wherein a variety of measurements are used to weight assets and liabilities. The mixed measurement model can be seen as one of the most effective methods of providing the relevant information to users in a manner that covers multiple aspects of situations based on gathered data. Eclectic measurement approach views each problem in the context of validity to paramount. The drive behind this method is due to our belief that certain issues require more attention than already being received. Eclectic measurement can be viewed as the intensive research as it focuses on concerns related to social sciences (Armstrong, S. J., n.d.). The eclectic method's primary goal is to pose a critical question that often times generates more discussion. This form creates more questions and in regards to the subject and overall development of the method, ensuring higher quality results.

7.6 - Quantitative and Qualitative Methods

Quantitative data deals with quantities, values or numbers—making data measurable. This can then be converted and processed into mathematical information that can be used for a variety of purposes. The result is often in the form of statistics that can be interpreted and used based on the user's requirements. Qualitative data is defined as data that is more so related to quality and is thus more descriptive rather than numerical in nature. Qualitative data is generally not measurable and is usually gained through observation (Anastasia, n.d.).

The first method of acquiring quantitative data would be a survey. Closed-ended questions in surveys will often be accompanied by predetermined answer choices (Anastasia, n.d.). This would be an ideal choice for surveying a large amount of people and allowing for generalization out of the results. Two specific drawbacks include the lack of details and the restriction respondents may feel due to the lack of freedom in the response choices. A second method of acquiring quantitative data would be an interview. A one-on-one interview with a set of predetermined questions would serve as a structured way of acquiring quantitative data. This set up would also allow for the researcher to make any needed clarifications. A large drawback would be the inability to cover a wider large sample size, due to taking a large amount of time and even money depending on circumstances. The final method of acquiring quantitative data is a more straightforward approach, observation. Data can be collected through basic observation while keeping key questions in mind such as "why" and "how." It is one of the most inexpensive methods of acquiring data, but due to the data collected resting solely on the observer, if any bias is present, results may become skewed.

Data analysis of quantitative data is much simpler than qualitative data, because of the simplicity of the data itself. It is important to summarize quantitative data, because it will help the researcher analyze patterns, relationships, and connections between various groups of data (McLeod, S. 2018). Statistics of

quantitative data can also be descriptive or inferential. According to Saul McLeod (2018), author of Simply Psychology, there are several key features of proper quantitative data analysis:

- 1) Quantitative researchers try to eliminate as many outside variables as they can, by conducting their research inside of a lab.
- 2) Their research is conducted in a way that is reported without bias, and is separated from all other groups of data.
- 3) The goal of the study is determined before the study begins.
- 4) For the researcher at hand, the reality of the experiment is subjective, and data seen by people outside of the experiments are expected to have a different interpretation.
- 5) Quantitative research is used to support or reject the presence of theories.

Quantitative research also has its own set of strengths and limitations. One of the main limitations of quantitative research is that experiments do not take place in natural settings, and participants usually do not explain their choices in the experiment (McLeod, S. 2018). Another large downside of quantitative research is that most researchers use it for confirmation bias, which is when a researcher is conducting an experiment to confirm something they already believe to be true. One major strength of quantitative research is that it can be used to test or validate currently known theories. Another major strength of quantitative research is that the research is less open to ambiguities and interpretation, which can be useful when researchers are trying to prove something to be true.

One of the most widely used qualitative methods of obtaining research would be paper surveys or questionnaires. These are often structured with short, open-ended questions that require detailed answers. Quotas are generally made before giving out surveys or questionnaires, and should be met before given any conclusion from the data they give. A major drawback for this method is the large amount of detailed information that will make the analysis of the data cumbersome. A second method of obtaining qualitative data would be focus groups. This is an interview method, in a group atmosphere. Each group is designated a moderator who is the one controlling much of the conversation flow. Focus groups are great sources of qualitative data because they allow individuals to talk to each other in a personal setting, and are generally ethnically and socially diverse to make correspondence between individuals in the focus group friendlier. (Anastasia n.d.)

Qualitative research has been often referred to as “endlessly creative and interpretive” (McLeod, S. 2018). Data obtained from qualitative research can be massive, and compressing all of the data into something meaningful for the study can be quite cumbersome. Because of this, researchers and scientists have come up with ways to make sense of the data at hand. Most common methods are known as content analysis, grounded theory, or discourse analysis. The most notable designs of qualitative research include but are not limited to:

- 1) Nothing observed for qualitative data can be taken for granted, and the context in which the qualitative data is observed in has to be considered when analyzing the data.
- 2) Qualitative research is purely an interpretive process, and all researchers involved in an experiment must speak for themselves to provide their own interpretations.
- 3) Qualitative research can only be conducted with active participation from the researcher.
- 4) The design of the study will (and should) evolve during the course of the research.
- 5) For a qualitative researcher, there is no single reality, and everything is open to interpretation.
- 6) Theory is all data driven, which will emerge from part of the qualitative research process.

(McLeod, S. 2018)

7.7 - Results and Findings Presentation

The results and findings sections is where the findings of the study are reported based on the research gathered in prior sections. It is necessary to lay out the results in a logical order, usually chronological, so that it makes sense to the reader. The results and findings section is important when data is gathered through one's own research. It is important to keep the original hypothesis in mind, as the results are meant to address this and either confirm or reject the hypothesis. When providing results of research, one should try to only include findings relevant to the study or data that is relevant to the hypothesis. All other data and findings can be gone over in previous sections of the paper, such as in the introduction. There are two good organizational approaches when forming a results section, each with their own benefits (*Research Guides: Organizing Your Social Sciences Research Paper: 7. The Results*).

One approach is to present a synopsis of the results followed by key findings. This approach allows the reader to take in all key findings without having to read through the entire section. Presenting all the findings at the beginning allows for some of the findings to be paired if they are correlated although why the correlation may exist should not belong in this section as it is not a true result. After presenting all results, the explanations to the results will follow so that there is no ambiguity.

A second approach to presenting results is to present a result and then explain before moving onto another result. This approach is more appropriate for longer papers so that a thorough explanation can be presented for each result and how the results came about. All results can be given equal significance with this approach by not grouping findings together. When using this approach it is important to provide a conclusion that ties all the results together into one cohesive thought. (*Research Guides: Organizing Your Social Sciences Research Paper: 7. The Results*)

With either of these approaches if any visual aid is used to help clarify or describe the results, it is important that they are relevant to the findings. The results and findings section is comprised of plain text with supporting visuals. It is important to explain the visual and why it is relevant to the text. Visual aids are best for complex results where the visual aids will help the reader grasp the findings. There are findings where a visual aid is crucial to understanding the result (Chan, P., n.d.). If any visual aid is being used it is important to use the correct formatting for them so they can be referred to in the text. Figures need to be referred to correctly according to the style being used.

It is important to interpret results in relation to the research question. Reporting the data isn't the same as interpreting the data, so it is important both to analyze the data and describe why it is relevant. When interpreting the results, one should not have any bias so that the results are not distorted. Negative findings and results should be included as well in order to show the full picture of the study. Even if the results are negative they are still results of the study and thus should be included.

7.8 - Concise Summary

The most effective way to produce meaningful research is by collecting meaningful data. Data collection starts with the methods and technologies behind the collection process.

Types of observation include naturalistic observation, participant observation, and controlled observation. Each type of observation comes with its pros and cons along with technologies that can facilitate data collection. Another way that data can be collected is using questionnaires, but it is important how they are implemented. It is more important how one wants to ask questions as this influences the answers from the participants. Questionnaires can be delivered in many methods, but it is important to not cause anxiety in the participants.

Interviews are a very valuable way to obtain data from individuals of interest. As with observation, there are multiple types of interview methods: group interviews, unstructured interviews, and structured interviews. The most common method is structured interviews, as this is the best way to compare data in a consistent manner. With all these methods of data collection, it is important to implement a larger range of approaches to effectively measure and explain the effects of data. Mixed measurement is defined as an approach wherein a variety of measurements are used to gather data. After figuring out how to represent the data there will be two types of data: quantitative and qualitative. After the data is collected and processed it is important to effectively communicate the results of the study. One must present all data clearly and what it means to the study. All results should be included in the findings, including results that do not support the initial hypothesis.

7.9 - Extended Resources

Descriptions & Links

1. Overview of Qualitative and Quantitative Data Collection Methods

<https://www.cleverism.com/qualitative-and-quantitative-data-collection-methods/>

2. Eclectic Research and Construct Validation

<https://www.cleverism.com/qualitative-and-quantitative-data-collection-methods/>

3. Observational Methods

https://cirt.gcu.edu/research/developmentresources/research_ready/descriptive/observational

4. Reporting Research Findings

<http://www.nus.edu.sg/celc/research/books/cwtuc/chapter04.pdf>

5. Naturalistic Observation in Psychology

<https://www.verywellmind.com/what-is-naturalistic-observation-2795391>

6. The Beagle Voyage

<https://www.britannica.com/biography/Charles-Darwin/The-Beagle-voyage>

7. What's the difference between qualitative and quantitative research?

<https://www.snapsurveys.com/blog/qualitative-vs-quantitative-research/>

8. Simply Psychology – Observation Methods

<https://www.simplypsychology.org/observation.html>

9. Organizing your Social Sciences Research

<https://libguides.usc.edu/writingguide/results>

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