**QUANTITATIVE METHODS**

**INFOSYS 313**

**Catherine C. Daffon**

**2023**



**UNIVERSITY OF SOUTHERN MINDANAO**

**Kabacan, Cotabato**

(Flyleaf)

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2. Implement quality educational programs;
3. Guarantee competent educational service providers;
4. Spearhead need-based research outputs for commercialization, publication, patenting, and develop technologies for food security, climate change mitigation and improvement in the quality of life;
5. Facilitate transfer of technologies generated from research to the community for sustainable development;
6. Strengthen relationship with stakeholders;
7. Sustain good governance and culture sensitivity; and
8. Comply to customer, regulatory and statutory requirements.

**PREFACE**

In today's fast changing and data-driven world, the ability to evaluate and interpret quantitative data is critical. Whether you're a student, researcher, business professional, or simply inquisitive about the power of numbers, this module is methodically intended to provide students with crucial tools and approaches for making educated data-driven decisions.

The field of Quantitative Methods resides at the intersection of mathematics, statistics, and computer science. It offers a systematic and rigorous approach to problem-solving and decision-making through quantitative analysis. From conducting surveys and experiments to making predictions and modeling complex systems, the applications of quantitative methods span across various disciplines. This module serves as a stepping stone, introducing students to the fundamental concepts of quantitative research and analysis, laying a solid foundation for comprehending more advanced statistical topics. By engaging in this module, students will learn how to collect, summarize, and interpret data using descriptive statistics.

Data analysis in the modern world often entails making use of technology. As a result, this course also covers a range of data analysis techniques utilizing industry-software tools. Navigating through data sets, applying statistical tests, and visualizing results will all be significant components of a student's learning journey. The ultimate purpose of this module is to instill in students the confidence to critically assess real-world problems using quantitative methodologies. The capacity to make data-driven judgments is a highly sought-after skill that can considerably improve professional chances and enrich daily living. Throughout this learning journey, students will experience interactive examples, practical exercises, and real-world case studies to reinforce their understanding and apply their knowledge to realistic settings.

Furthermore, this module will be a useful reference and review for students' Quantitative Methods assignments, exams, and quizzes. Students will be given assessment activities at the end of each part to demonstrate their understanding of the module's various lessons.

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**COURSE GUIDE**

**Course Information**

|  |  |
| --- | --- |
| **Course Title** | **Quantitative Methods** |
| **Course Code** | **InfoSys 313** |
| **Pre-requisite/Co-requisite** | **None** |

**Course Description**

The course on Quantitative Methods offers students a comprehensive introduction to the fundamental concepts and techniques used in quantitative research across various fields. Through theoretical explanations, practical exercises, and data analysis, students will develop a strong foundation in quantitative research methods. The main goal of the course is to empower students to design, implement, and effectively analyze quantitative research projects. Furthermore, the course covers principles and techniques of research in different disciplines, with a focus on formulating research questions, designing studies, collecting and analyzing data, as well as drawing valid conclusions. Emphasis will be placed on quantitative research methodology, providing students with a well-rounded understanding of research methods applicable in both academic and professional settings.

**Course Objectives/Outcomes**

Upon passing the course, you must be able to:

1. Understand the basic principles of quantitative research and its relevance in various disciplines.
2. Identify different research designs and choose appropriate quantitative methodologies for specific research questions.
3. Formulate clear and relevant research questions suitable for quantitative investigation.
4. Analyze and interpret research data using appropriate statistical and quantitative analysis techniques.
5. Understand basic statistical concepts and tests used in research.
6. Understand the importance of ethical considerations in research.

**Course Learning/Study Plan/Schedule**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Week/Date (Deadlines)** | **Topic** | **Teaching and Learning Activities** | **Learning Materials** | **Assessment** |
| Week 1-2 | **Introduction to Quantitative Research**   * Overview of quantitative research methods * Why is Quantitative Research Important? * The role of quantitative research in various disciplines * Understanding research paradigms and approaches * Differentiating between qualitative and quantitative research approaches. * Exploring ethical considerations in quantitative research. | Lecture and Discussion  Modules  Independent Learning | Downloadable Slides/Modules  Computer/  Mobile Phone | Homework 1  Quiz 1 |
| Week 4-6 |  | Lecture and Discussion  Modules  Independent Learning  Lecture Videos | Downloadable Slides/Modules  Computer/Mobile Phone | Homework 2  Quiz 2 |
| Week 7-8 |  | Lecture and Discussion  Lecture Videos  Modules  Readings  Independent Learning | Downloadable Slides/Modules  Computer/Mobile Phone | Homework 3  Quiz 3 |
| Week 9 | **Midterm Examination** | | | |
| Week 10-12 |  | Lecture and Discussion  Lecture Videos  Modules  Readings  Independent Learning | Downloadable Slides/Modules  Computer/Mobile Phone | Homework 4  Quiz 4 |
| Week 16 |  | Lecture and Discussion  Lecture Videos  Modules  Readings  Independent Learning | Downloadable Slides/Modules  Computer/Mobile Phone | Homework 6  Quiz 6  Final Project |
| Week 17 |  | Lecture and Discussion  Lecture Videos  Modules  Readings  Independent Learning | Downloadable Slides/Modules  Computer/Mobile Phone | Homework 7  Quiz 7 |
| Week 18 | **Final Examination** | | | |

**Course Requirements/Assessment and Evaluation Scheme/Grading System**

|  |  |
| --- | --- |
| **MIDTERM** | |
| **Requirement/Assessment Task** | **Percentage** |
| Homework | 20 |
| Online Quizzes | 45 |
| Midterm Exam | 35 |
| **TOTAL** | **100%** |
|  |  |
| **FINAL TERM** |  |
| **Requirement/Assessment Task** | **Percentage** |
| Homework | 20 |
| Online Quizzes | 45 |
| Final Exam/Final Project | 35 |
| **TOTAL** | **100%** |
|  |  |
| **FINAL GRADE** |  |
| Midterm | 50% |
| Final Term | 50% |
| **TOTAL** | **100%** |

**House Rules/Class Policies**

1. Students are required to enroll in the course VLE where all course materials are uploaded for easy access.
2. Each student is encouraged to have a computer, either a desktop or a laptop, for convenience in doing tasks required for the course.
3. Students are enjoined to attend the online Zoom lectures. If a student cannot attend the lectures, the recording will be posted on the course VLE for downloading and viewing offline.
4. Students should wear appropriate clothing while attending the online class.
5. Tasks should be submitted on time on any of the dates specified by the instructor.
6. Students are encouraged to communicate with the instructor via any of the media specified by the instructor.
7. Plagiarism, under specific conditions, can be a cybercrime and, therefore, is highly discouraged; it must not be taken lightly. Tasks are required to be checked using any online plagiarism checker; plagiarism result and receipt must be submitted together with the tasks on the deadlines set by the instructor.

**CHAPTER 1**

**Introduction to Quantitative Methods**

**Intended Learning Outcomes**

By the end of this topic/chapter, you must be able to:

1. Understand the foundational concepts of quantitative research and its place in the broader research landscape.
2. Understand the significant role of quantitative research across diverse fields, highlighting its applications, advantages, and limitations.
3. Differentiate between qualitative and quantitative research methods
   1. **Overview of quantitative research methods**

* **What is Quantitative Research?**

*Quantitative research* is the investigation of an issue using numbers to establish meaning for behavior. In the market research world, numbers give insight into consumer behavior, but quantitative research can and is used to explain other kinds of performance, as well. Scientists and analysts in both the social sciences and the natural ones use numerical data to apply significance to any number of different kinds of phenomena.

* **What Are Some Similarities Between Qualitative and Quantitative Research?**

*Quantitative and qualitative research methods are similar primarily because they are both methods of research that are limited by variables***.** Additionally, qualitative and quantitative research methods can be used to study the same phenomenon. However, *qualitative research* is most often used to study people, while quantitative *research* typically measures the frequency or total of something. Regardless, both methods are often capable of investigating the same hypothesis.

For example, a qualitative study can gather information on the effectiveness of welfare policies by analyzing self-reported financial information from welfare recipients. On the other hand, quantitative research can be used to look at the financial situations of the same recipients by analyzing financial documents. Both studies analyze the same kind of information and investigate the same question. However, the information that is being analyzed is what is different.

Qualitative and quantitative research methods are also similar *because both methods are limited by variables.* In the previous example, the qualitative research method is limited because self-reported information is not always accurate. The quantitative research method is also limited because not all financial information is always documented.

Lastly, both research methods are similar because both methods are affected by the researcher conducting the research. For example, each researcher chooses which information to gather and how to interpret the data. This has a significant impact on the outcome of research, regardless of which method is used.

* **What Is an Example of Quantitative Observation?**

An example of a quantitative observation is measuring the surface of an oil painting and finding its dimensions to be 12 inches by 12 inches. A quantitative observation occurs when a researcher takes a measurement that is recorded in an objective number of units.

Quantitative observations are so called because they are observations that can be quantified; that is, that they can be represented by numbers. This is contrasted with qualitative observations, which are *subjective observations based on descriptive information*. An example of a qualitative observation is someone remarking that a painting is beautiful, or that it has a musty odor to it.

# **What Is the Meaning of Quantitative Techniques?**

***Quantitative techniques* include methods that focus on objective measurements and analyzing numbers in order to draw conclusions about research subjects.**These methods include *polls, questionnaires and surveys.* They also either describe a phenomenon by measuring it once or perform an experiment in which researchers measure the phenomenon before and after they introduce a treatment.

Researchers use quantitative techniques across a number of disciplines including communication studies, medical studies, statistics and a host of other social sciences like education. Researchers gather information with specific research instruments in order to get an objective measurement. With the information gathered from these observations, researchers make inferences about a larger population after looking at a representative sample size.

Quantitative techniques must have high reliability so that other researchers have the ability to replicate the studies with the previous data collection or a similar one and check the validity of the results. They must also follow a carefully constructed research design that eliminates the possibility of contamination from outside factors that potentially affect the phenomenon under investigation. *Valid results* mean that researchers have the ability to see causation or predict future results of the phenomenon. Furthermore, they can generalize concepts more widely and explain their results with numbers and statistics.

* 1. **Why is Quantitative Research Important?**

The purpose of quantitative research is *to attain greater knowledge and understanding of the social world.* Researchers use quantitative methods to observe situations or events that affect people.Quantitative research produces *objective data* that can be clearly communicated through statistics and numbers. We do this in a *systematic scientific way* so the studies can be *replicated* by someone else.

The data is primarily used to:

* Find patterns and averages
* Make predictions
* Test causal relationships
* Generalize results to wider populations

## What Is the Basic Methodology/Procedure for a Quantitative Research Study?

Quantitative research is structured around the scientific method. After observing the situation to be investigated, the researcher forms a hypothesis and then uses deductive reasoning by predicting how the data should look if the hypothesis is true, after collecting the data and analyzing it to confirm or reject the hypothesis.

The basic procedure of a quantitative research design is as follows:

1. Make observations about something unknown, unexplained or new. Investigate current theories or trends surrounding the problem or issue.
2. Formulate a hypothesis to explain your observations.
3. Predict outcomes based on your hypothesis and formulate a plan to test your predictions.
4. Collect and process your data using one or more of the methods below.
5. If your prediction is confirmed, verify your results, draw your final conclusions and present your findings. If it is disconfirmed, form a new hypothesis based on what you have learned and start the process over.
   1. **The role of quantitative research in various disciplines**

**Quantitative research** is a powerful and widely used approach in various academic disciplines and industries. It involves the systematic collection (surveys/questionnaires/experiments), analysis, and interpretation of numerical data to identify patterns, relationships, and trends. In this lecture, we will explore the significant role of quantitative research across diverse fields, highlighting its applications, advantages, and limitations.

* *Quantitative Research in the Social Sciences:*

**Psychology:** In psychology, quantitative research is employed to study human behavior, cognition, emotions, and mental processes. Surveys, experiments, and observational studies help researchers quantify variables, understand correlations, and make predictions.

**Sociology:** Sociologists use quantitative methods to study social phenomena, demographics, and trends. Large-scale surveys, statistical analysis, and data mining enable researchers to draw generalizations about human societies and social structures.

**Economics:** Quantitative research is crucial in economics to analyze economic trends, consumer behavior, and market dynamics. **Econometrics and mathematical modeling** are commonly used to forecast economic outcomes and guide policy decisions.

Econometrics - is the use of statistical and mathematical models to develop theories or test existing hypotheses in economics and to forecast future trends.

* *Quantitative Research in the Natural Sciences:*

**Physics:** Quantitative research forms the foundation of physics, enabling scientists to formulate mathematical equations, perform experiments, and validate theories. Statistical analysis is crucial in analyzing experimental data and verifying hypotheses.

**Biology:** Biologists use quantitative research to measure and analyze biological processes, genetics, and ecological systems. Techniques like *bioinformatics* and *biostatistics* aid in understanding complex biological data.

*Biostatistics* – the branch of statistics that deals with data relating to living organisms.

*Bioinformatics* – the science of collecting and analyzing complex biological data such as genetic codes.

**Chemistry:** Quantitative research in chemistry involves precise measurements, calculations, and statistical analysis. It is instrumental in determining chemical properties, reactions, and analyzing molecular structures.

* *Quantitative Research in Health and Medicine:*

**Medical Research:** In medical research, quantitative methods are used to conduct clinical trials, analyze patient data, and assess treatment efficacy. Epidemiological studies rely heavily on quantitative data to investigate disease patterns and risk factors.

*Epidemiological* – relating to the branch of medicine which deals with the incidence, distribution, and control of disease.

**Public Health:** Public health professionals employ quantitative research to assess the health of populations, track disease outbreaks, and evaluate the impact of health interventions. Data-driven decisions are vital in shaping public health policies.

* *Quantitative Research in Business and Economics:*

**Market Research:** Quantitative research is extensively used in market research to gather data on consumer preferences, market trends, and competition. Surveys, questionnaires, and statistical analysis aid businesses in making informed decisions.

**Financial Analysis:** In finance, quantitative research involves modeling financial markets, risk assessment, and developing investment strategies. Techniques like econometrics and time-series analysis are valuable in predicting financial outcomes.

* *Quantitative Research in Education:*

**Assessment and Evaluation**: Quantitative research plays a crucial role in educational assessment and evaluation. Standardized testing, surveys, and statistical analysis help measure student performance and evaluate the effectiveness of educational programs.

**Educational Psychology:** Researchers in educational psychology use quantitative methods to study learning processes, cognitive development, and educational interventions.

* **Advantages and Limitations of Quantitative Methods**
* ***Objectivity*:** Quantitative research reduces the influence of personal biases, as data is analyzed using statistical techniques.
* ***Replicability****:* The systematic nature of quantitative research allows for easy replication and validation of findings.
* ***Generalizability:*** Large sample sizes and statistical analysis facilitate the generalization of results to broader populations.
* ***Precision:*** Quantitative data provides precise measurements and allows for detailed analysis.
* ***Causality****:* Experimental designs in quantitative research allow researchers to establish cause-and-effect relationships.
* **Limitations of Quantitative Research**
* ***Lack of Context:*** Quantitative research may not capture the richness and context of human experiences.
* ***Limited Scope:*** Certain phenomena may be challenging to quantify, leading to the omission of essential factors.
* ***Assumptions of Normality*:** Some statistical techniques rely on assumptions of data normality, which may not always be met.
* ***Difficulty in Data Collection:*** Gathering large-scale quantitative data can be time-consuming and expensive.
* ***Reduced Flexibility:*** The rigid nature of quantitative research may hinder exploration of unexpected findings.
* **Conclusion:**

Quantitative research plays a fundamental role in advancing knowledge and understanding across various disciplines. Its ability to provide empirical evidence, make predictions, and identify trends has enabled groundbreaking discoveries and influenced decision-making processes in academia, industry, and policymaking. However, it is crucial to acknowledge its limitations and combine it with qualitative research to achieve a comprehensive understanding of complex phenomena.

**1.4 Understanding research paradigms and approaches**

Researchers use several methods to conduct quantitative research. Here are a few of the common methods used:

* ***Survey research***

Survey research entails gathering data from people interactively. Often researchers use online questionnaires and paper, email or phone surveys to gather data from individuals. The researchers might decide on certain parameters for the surveys, such as limiting them to a specific age groups or income levels. A survey might ask young parents how often they use child care during the workweek, for example.

* ***Polls***

Researchers sometimes use polls with questions to conduct studies. The poll questions usually include information about a person's age and demographics. Polls generally use a format that asks whether the poll participant agrees with a statement or asks them to rate their level of agreement on a scale. Researchers typically conduct polls via phone or in-person interviews. In politics, campaigns use polls to estimate public opinion on issues or whether they support a proposal.

* ***Secondary research***

Rather than collecting data themselves, quantitative researchers can use existing data. They might rely on computer databases, government sources and educational institutions. The researchers also might build upon the quantitative research of others, adding sources and conducting their own analysis of previous research.

* ***Data analysis***

Quantitative researchers typically approach their work in one of the following ways when analyzing data:

* ***Observational research***: Researchers collect the data and seek to present observations based on the results. For example, a study of home prices in a specific area might include whether the prices rose or fell over the period of the study.
* ***Correlational research:*** Researchers seek to find the relationship between different variables. A study, for example, might compare the heart disease rate in people in their 40s who smoked throughout their life against people of a similar age who did not smoke.
* ***Testing* research:** Researchers create a hypothesis and variables based on the hypothesis, then conduct experiments to test the hypothesis. For example, a researcher might hypothesize that a person runs faster after drinking caffeine and then create an experiment to test that theory.

**1.5 Exploring ethical considerations in quantitative research**

**Ethical considerations** in research are a set of principles that guide your research designs and practices. Scientists and researchers must always adhere to a certain code of conduct when collecting data from people.

The goals of human research often include understanding real-life phenomena, studying effective treatments, investigating behaviors, and improving lives in other ways. What you decide to research and how you conduct that research involve key ethical considerations.

These considerations work to

* protect the rights of research participants
* enhance research validity
* maintain scientific or [academic integrity](https://www.scribbr.com/plagiarism/academic-dishonesty/)

## Why do research ethics matter?

Research ethics matter for scientific integrity, human rights and dignity, and collaboration between science and society. These principles make sure that participation in studies is voluntary, informed, and safe for research subjects.

Defying research ethics will also lower the credibility of your research because it’s hard for others to trust your data if your methods are morally questionable.

Even if a research idea is valuable to society, it doesn’t justify violating the human rights or dignity of your study participants.

## Types of ethical issues

There are several ethical issues you should always pay attention to in your research design, and these issues can overlap with each other.

## Voluntary participation

**Voluntary participation** means that all research subjects are free to choose to participate without any pressure or coercion. All participants are able to withdraw from, or leave, the study at any point without feeling an obligation to continue. Your participants don’t need to provide a reason for leaving the study. It’s important to make it clear to participants that there are no negative consequences or repercussions to their refusal to participate. After all, they’re taking the time to help you in the [research process](https://www.scribbr.com/category/research-process/), so you should respect their decisions without trying to change their minds.

Example of voluntary participation:

When recruiting participants for an [experiment](https://www.scribbr.com/methodology/experimental-design/), you inform all potential participants that they are free to choose whether they want to participate, and they can withdraw from the study anytime without any negative repercussions.

Voluntary participation is an ethical principle protected by international law and many scientific codes of conduct.

## Informed consent

**Informed consent** refers to a situation in which all potential participants receive and understand all the information they need to decide whether they want to participate. This includes information about the study’s benefits, risks, funding, and institutional approval.

Example of informed consent:

You recruit participants outside a train station for a quick survey.

You make sure to provide all potential participants with all the relevant information about

* what the study is about
* the risks and benefits of taking part
* how long the study will take
* your supervisor’s contact information and the institution’s approval number

You also let them know that their data will be kept confidential, and they are free to stop filling in the [survey](https://www.scribbr.com/methodology/survey-research/) at any point for any reason. They can also withdraw their information by contacting you or your supervisor.

Usually, you’ll provide participants with a text for them to read and ask them if they have any questions. If they agree to participate, they can sign or initial the consent form. Note that this may not be sufficient for informed consent when you work with particularly vulnerable groups of people.

If you’re collecting data from people with low literacy, make sure to verbally explain the consent form to them before they agree to participate.

For participants with very limited English proficiency, you should always translate the study materials or work with an interpreter so they have all the information in their first language.

In research with children, you’ll often need informed permission for their participation from their parents or guardians. Although children cannot give informed consent, it’s best to also ask for their [assent](https://irb.ucsf.edu/children-and-minors-research#defining) (agreement) to participate, depending on their age and maturity level.

## Anonymity

**Anonymity** means that you don’t know who the participants are and you can’t link any individual participant to their data.

You can only guarantee anonymity by **not** collecting any personally identifying information—for example, names, phone numbers, email addresses, IP addresses, physical characteristics, photos, and videos.

In many cases, it may be impossible to truly anonymize [data collection](https://www.scribbr.com/methodology/data-collection/). For example, data collected in person or by phone cannot be considered fully anonymous because some personal identifiers (demographic information or phone numbers) are impossible to hide.

You’ll also need to collect some identifying information if you give your participants the option to withdraw their data at a later stage.

* **Data pseudonymization** is an alternative method where you replace identifying information about participants with pseudonymous, or fake, identifiers. The data can still be linked to participants but it’s harder to do so because you separate personal information from the study data.

Example of data pseudonymization:

You’re conducting a survey with college students. You ask participants to enter demographic information including their age, gender identity, nationality, and ethnicity. With all this information, it may be possible for other people to identify individual participants, so you pseudonymize the data.

Each participant is given a random three-digit number. You separate their personally identifying information from their survey data and include the participant numbers in both files. The survey data can only be linked to personally identifying data via the participant numbers.

## Confidentiality

**Confidentiality** means that you know who the participants are, but you remove all identifying information from your report.

All participants have a right to privacy, so you should protect their personal data for as long as you store or use it. Even when you can’t collect data anonymously, you should secure confidentiality whenever you can.

Example of confidentiality:

To keep your data confidential, you take [steps](https://ria.princeton.edu/human-research-protection/data/best-practices-for-data-a) to safeguard it and prevent any threats to data privacy. You store all signed consent forms in a locked file drawer, and password-protect all files with survey data.

Some research designs aren’t conducive to confidentiality, but it’s important to make all attempts and inform participants of the risks involved.

## Potential for harm

As a researcher, you have to consider all possible sources of harm to participants. Harm can come in many different forms.

* **Psychological harm:** Sensitive questions or tasks may trigger negative emotions such as shame or anxiety.
* **Social harm:** Participation can involve social risks, public embarrassment, or stigma.
* **Physical harm:** Pain or injury can result from the study procedures.
* **Legal harm:** Reporting sensitive data could lead to legal risks or a breach of privacy.

It’s best to consider every possible source of harm in your study as well as concrete ways to mitigate them. Involve your supervisor to discuss steps for harm reduction.

Make sure to disclose all possible risks of harm to participants before the study to get informed consent. If there is a risk of harm, prepare to provide participants with resources or counseling or medical services if needed.

Example of potential for harm:

In a study on stress, you survey college students on their alcohol consumption habits.

Some of these questions may bring up negative emotions, so you inform participants about the sensitive nature of the survey and assure them that their responses will be confidential.

You also provide participants with information about student counseling services and information about managing alcohol use after the survey is complete.

## Results communication

The way you communicate your research results can sometimes involve ethical issues. Good science communication is honest, reliable, and credible. It’s best to make your results as transparent as possible.

### Plagiarism

[**Plagiarism**](https://www.scribbr.com/category/plagiarism/) means submitting others’ works as your own. Although it can be unintentional, copying someone else’s work without proper credit amounts to stealing. It’s an ethical problem in research communication because you may benefit by harming other researchers.

[*Self-plagiarism*](https://www.scribbr.com/plagiarism/self-plagiarism/) is when you republish or re-submit parts of your own papers or reports without properly citing your original work.

This is problematic because you may benefit from presenting your ideas as new and original even though they’ve already been published elsewhere in the past. You may also be infringing on your previous publisher’s copyright, violating an ethical code, or wasting time and resources by doing so.

In extreme cases of self-plagiarism, entire datasets or papers are sometimes duplicated. These are major ethical violations because they can [skew](https://www.scribbr.com/statistics/skewness/) research findings if taken as original data.

### **Research misconduct**

**Research misconduct** means making up or falsifying data, manipulating data analyses, or misrepresenting results in research reports. It’s a form of *academic fraud.*

These actions are committed intentionally and can have serious consequences; research misconduct is not a simple mistake or a point of disagreement about data analyses.

Research misconduct is a serious ethical issue because it can undermine [academic integrity](https://www.scribbr.com/plagiarism/academic-dishonesty/) and institutional credibility. It leads to a waste of funding and resources that could have been used for alternative research.

Example of misconduct (MMR vaccine misinformation) :

In 1998, Andrew Wakefield and others published a now-debunked paper claiming that the measles, mumps, and rubella (MMR) vaccine causes autism in children.

[Later investigations](https://www.webmd.com/brain/autism/news/20110105/bmj-wakefield-autism-faq) revealed that they fabricated and manipulated their data to show a nonexistent link between vaccines and autism. Wakefield also neglected to disclose important conflicts of interest, and his medical license was taken away.

This fraudulent work sparked vaccine hesitancy among parents and caregivers. The rate of MMR vaccinations in children fell sharply, and measles outbreaks became more common due to a lack of herd immunity.

In reality, there is no risk of children developing autism from the MMR or other vaccines, as shown by many large studies. Although the paper was [retracted](https://retractionwatch.com/2019/11/18/andrew-wakefields-fraudulent-paper-on-vaccines-and-autism-has-been-cited-more-than-a-thousand-times-these-researchers-tried-to-figure-out-why/), it has actually received thousands of citations.

**Formative Assessment 1 (Quiz # 1)**

Identify the concepts pertained to in the following numbers.

**Chapter/Module 1 Summary**

**Chapter/Module 1 References**

**Answer Key**