Bangabandhu Sheikh Mujib Medical University Journal 2024;17(3):e75368 bsmmuj.org
ISSN 2074-2908 | eISSN 2224-7750 | © CC-BY-NC-4.0 | Open access doi: 10.3329/bsmmuj.v17i3.75368

EDITORIAL

Unraveling research: Understanding scientific reasoning

Scientific reasoning is a systematic process of drawing conclusions based on existing knowledge and observations.[1] This dictates how researchers develop and test hypotheses, select appropriate study designs, collect and analyse data accordingly, and draw valid and reliable conclusions.[2] This logical framework ensures that the research process is systematic, coherent, and critically thought out, ensuring the rigor of the research. By applying scientific reasoning, researchers can identify and mitigate potential sources of bias, ensure the appropriate use of statistical methods, and present findings in a transparent and accountable manner. This process helps in identifying gaps in knowledge, addressing research questions systematically, and contributing valuable insights to the scientific community and beyond.

Overview of major scientific reasoning types

Understanding and applying different types of scientific reasoning can significantly enhance the quality and relevance of one's work. Three major types of scientific reasoning are widely used[2]:

Inductive reasoning

Inductive reasoning is a logical process where a specific observation or data are used to develop broader generalisations.[3] It is a bottom-up approach that begins with gathering raw data towards identifying patterns and developing theories based on these patterns **(FIGURE 1)**. This type of reasoning is essential in exploratory research, where the goal is to uncover new insights without preconceived hypotheses. For instance, a researcher observing that certain plants thrive in sunlight may generalize that sunlight is beneficial for plant growth overall. In inductive reasoning, specific observations are used to develop a broader generalization or theory. The researcher starts with specific instances (certain plants thriving in sunlight) and then makes a general conclusion (sunlight is beneficial for plant growth overall). Inductive reasoning is commonly used in exploratory research to form hypotheses or identify patterns, especially in fields where existing knowledge is limited This allows researchers to identify trends and regularities in their research population, forming the basis for further study. However, it is important to note that inductive conclusions are probabilistic — they suggest what might be true based on observations, but they do not provide certainty.[4] The strength of an inductive reasoning depends on the quality and quantity of supporting evidence, as well as the representativeness of the observed sample.

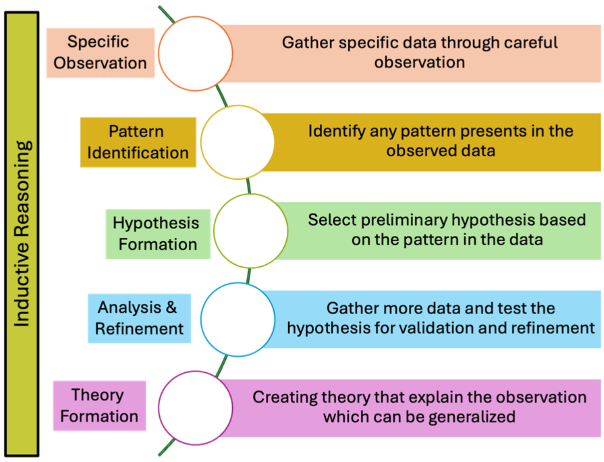

FIGURE 1 Segments of inductive reasoning

Deductive reasoning

Deductive reasoning is a logical process that starts with a general theory or hypothesis and tests it through collecting focused observations or data.[3] This is a top-down approach that starts based on prior knowledge, often a well-established theory or assumption from which a researcher derives a hypothesis. They then collect data to see if it supports or refutes the hypothesis **(FIGURE 2)**. For example, let us assume that a theory posits that all cats are white. The reasoning process begins with a general premise (i.e., all cats are white) and moves towards a specific conclusion (any newly observed cat will also be white). When an observation contradicts this prediction (e.g., observing a black cat), it challenges the hypothesis and potentially the

Received: 8 Aug 2024 | **Accepted:** 8 Aug 2024 | **Published online:** 13 Aug 2024
Responsible Editor: M Mostafa Zaman

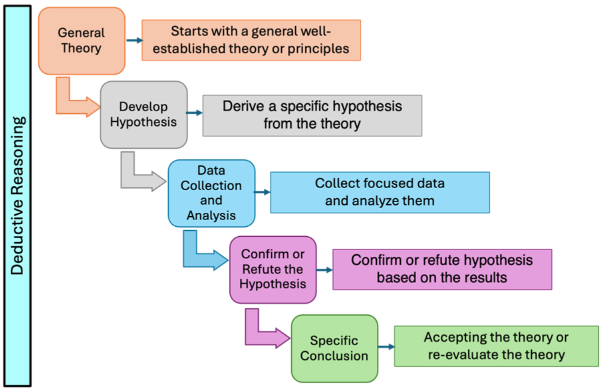

FIGURE 2 Segments of deductive reasoning

underlying theory, necessitating a re-evaluation. Deductive reasoning is foundational in experimental research, where scientists aim to test hypotheses in controlled settings.[5] It is highly valuable for confirming theories and establishing causal relationships.

Abductive reasoning

Abductive reasoning is a logical process that seeks to find the most likely explanation for a situation where the available observations are insufficient to form a comprehensive explanation. It involves making educated guesses based on the best available information, logic, and intuition[6], often in situations of data incompleteness.[7] This reasoning process involves considering all likely explanations and selecting the one that best fits the evidence, even if it is not conclusively proven **(IGURE 3)**. Unlike inductive or deductive reasoning, which often follow more structured pathways, abductive reasoning is more flexible and

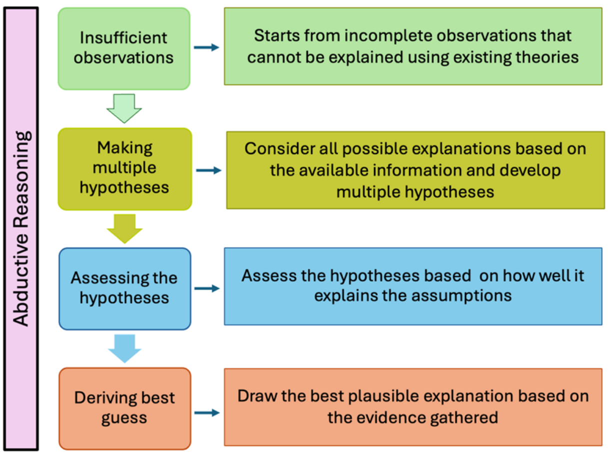

FIGURE 3 Segments of abductive reasoning

creative.[8] A classic example involves a detective arriving at a crime scene and finding a window broken and valuables missing. The most likely hypothesis might be a burglary. Abductive reasoning involves starting with an incomplete set of observations and seeking the most plausible explanation. In this case, the detective considers the available evidence (a broken window and missing valuables) and concludes that a burglary is the most likely explanation. This type of reasoning is often used in situations where there are several possible explanations, and the goal is to identify the most reasonable one, even if it is not conclusively proven. Abductive reasoning is particularly useful in fields like diagnostic medicine or forensic science, where quick, yet logical, conclusions are necessary.

A health research example of scientific reasoning

Let us consider a health research scenario where the overarching aim of the researchers is to investigate the high prevalence of obesity in low-income neighborhoods.

Inductive reasoning approach

Researchers observe a high prevalence of obesity in several low-income neighbourhoods. They collect data on dietary habits, physical activity levels, built environment, and access to healthy food in these neighbourhoods. After analysing the data, they form a general hypothesis: "Living in low-income neighboirhoods is associated with a higher prevalence of obesity due to limited access to healthy food options and fewer opportunities for physical activity." This is inductive because it moves from specific observations to a broader generalisation.

Deductive reasoning approach

Researchers started with the general theory that living environmental factors significantly influence health outcomes. Researchers hypothesize that "If a neighbourhood has limited access to fresh produce and safe spaces for exercise, then its residents will have higher rates of obesity." They then design a study to test this hypothesis by comparing obesity in neighbourhoods with varying levels of access to healthy food and exercise opportunities. This is deductive because it starts with a general principle and moves to a specific prediction that can be tested.

Abductive reasoning approach

Researchers notice a sudden increase in obesity rates in a particular low-income community. They consider several possible explanations:

a) A new fast-food restaurant has opened in the area.

b) Recent budget cuts have reduced physical education programmes in local schools.

c) A large employer in the area has closed their establishment, leading to increased unemployment and stress.

Researchers decide that the closure of the local employer is the most likely explanation and focus their research on the associations of job loss and economic stress with obesity. This is abductive reasoning because it involves making the best guess or inference based on the available information, seeking the most plausible explanation for the observed phenomenon.

Why is understanding scientific reasoning so crucial?

Understanding scientific reasoning is crucial for several important reasons:

Enhances critical thinking: Knowledge of different reasoning approaches (inductive, deductive, and abductive) helps researchers and consumers of research critically evaluate studies and their conclusions.

Improves research design: Understanding reasoning methods allows researchers to choose the most appropriate approach for their research questions, leading to more robust study designs. This, in turn, helps align research methods with the goals and nature of the inquiry.

Facilitates interpretation of results: Recognising the type of reasoning used helps in properly interpreting and contextualising research findings. This allows for a better assessment of the strengths and limitations of conclusions.

Enhances research validity: Proper application of reasoning approaches strengthens the logical foundations of research. This helps identify and avoid logical fallacies or weak inferences.

Supports evidence-based decision making: Understanding how conclusions are reached in research supports more informed policy and practice decisions. This allows for better evaluation of the quality and relevance of evidence. Understanding different reasoning approaches, especially abductive reasoning, can lead to creative problem-solving and hypothesis generation.

Conclusion

Scientific reasoning is fundamental to conducting rigorous research, interpreting results accurately, and making informed decisions based on scientific evidence. It promotes critical thinking, scientific literacy, and innovation-essential skills in today's complex, information-rich world. Each reasoning approach has its strengths and can be strategically employed to address different aspects of research questions, leading to more comprehensive and insightful findings.

Tanvir C Turin
Email: turin.chowdhury@ucalgary.ca
ORCID iD: https://orcid.org/0000-0002-7499-5050

Mohammad M H Raihan
Email: mohammadmojammel.rai@ucalgary.ca
ORCID iD: https://orcid.org/0000-0002-9945-1535

Nashit A Chowdhury
Email: nashit.chowdhury@ucalgary.ca
ORCID iD: https://orcid.org/0000-0002-1067-4450

Department of Family Medicine, Cumming School of Medicine, University of Calgary, Calgary, Alberta, Canada

Funding
No funds were received for this editorial.

Conflict of interest
We do not have any conflict of interest.

REFERENCES

1. Lee CQ, She HC. Facilitating students' conceptual change and scientific reasoning involving the unit of combustion. Res Sci Educ. 2010;40(4):479–504. DOI: https://doi.org/ 10.1007/ s11165-009-9130-4

2. Minnameier G. The Logicality of Abduction, Deduction and Induction. In: Bergman M, Paavola S, Pietarinen AV, Rydenfelt H, editors. Ideas in Action: Proceedings of the Applying Peirce Conference. Nordic Studies in Pragmatism 1. Helsinki, Nordic Pragmatism Network, Finland; 2010;239–251. Available from: https://www.nordprag.org/nsp/1/Minnameier.pdf

3. Ketokivi M, Mantere S. Two Strategies for Inductive Reasoning in Organizational Research. Acad Manag Rev. 2010 Apr;35(2):315–333. DOI: https://doi.org/ 10.5465/amr.35.2.zok315

4. Shin HS. Reasoning processes in clinical reasoning: from the perspective of cognitive psychology. Korean J Med Educ. 2019 Dec;31(4):299-308. DOI: https://doi.org/10.3946/kjme.2019.140.

5. Hyde KF. Recognising deductive processes in qualitative research. Qual Mark Res An Int J. 2000 Jun 1;3(2):82–90. DOI: http://dx.doi.org/10.1108/13522750010322089

6. Sadler-Smith E, Wray T. Abductive reasoning, creativity and the logic of intuition. In: Dörfler V, editor. Handbook of research methods on creativity [Internet]. Edward Elgar Publishing, UK; 2020 [cited 2024 Aug 7]. 111–125. Available from: https://www.e-elgar.com/shop/usd/handbook-of-research-methods-on-creativity-9781786439642.html

7. Lipscomb M. Abductive reasoning and qualitative research. Nurs Philos. 2012 Oct;13(4):244-256. DOI: https://doi.org/10.1111/j.1466-769X.2011.00532.x.

8. Kovács G, Spens KM. Abductive reasoning in logistics research. Int J Phys Distrib Logist Manag. 2005;35(2):132–144. DOI: https://doi.org/ 10.1108/09600030510590318