

SCIENTIFIC THINKING: WHO THINKS THIS WAY?

Rudina Lipi³¹⁹
Ilirjan Lipi³²⁰
Etleva Leskaj³²¹

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Abstract: *If the citizens of a country are well educated and make a good use of knowledge, are intelligent and well-informed, then they will undoubtedly make the best decisions, they will perceive clearly, they will understand without bias, thus directly affecting the quality of their live as the result of individual or public decisions, and even according to the pooling principle, all this will bring collective results. But being a mature decision-maker means orienting your decision through scientific thinking, and algorithmic thinking. What does the process of scientific thinking and reasoning mean, is there evidence of scientific thinking in the everyday life of citizens, do people use statistics, surveys, primary and secondary data for making decisions, what about their attitude and behavior about problem solving? Through scientific thinking in everyday life, many people make better decisions than others, because through their reasoning process these individuals judge using objective and not subjective criteria. Currently, in the social Albanian environment, personal decision-making is oversimplified not only by non-scientists, but also by scientists, academics, researchers or scholars, because they are often fatalistic in their judgment, thinking that the results are far less influenced by the quality of their decisions, or they think that they are powerless about the results. Although this is a complex and multi-dimensional topic, that may have different discussion perspectives or starting points, in this paper the principle of scientific thinking will be addressed in a descriptive and general outline, to alert the scientific community as well as to highlight the importance of why science and scientific thinking should be integrated into our daily algorithm of living, especially in this era of great advancement in artificial intelligence.*

Keywords: *Scientific thinking, society, everyday life, decision making, scientific method criteria.*

“... the most important instrument in research must always be the mind of man.”
W. I. B. Beveridge (1957)

Introduction

In our complicated world, our lives depend on many, many events and decisions outside of our immediate control as well as many within our control. Science as a way of making rational, evidence-based decisions about the natural world offers the best method we have of ensuring those decisions achieve what we want. [1, n.d., p.2]

³¹⁹ University College “Pavarësia Vlorë”, Department of Economy, Albania

³²⁰ University of Vlora, "Ismail Qemali", Department of Business Administration, Albania

³²¹ Tirana University, Department of Management, Albania

The most important decision you can make is about finance, health and public policy. According to many observations and assumptions, excluding the financial constrain, the decision-making of an individual is strongly influenced by his culture and psychological development too. From a rational point of view, the more financial limitations someone encounters, the more he needs a useful, well-informed and scientific decision-making. Although for example if someone take the decision to finance risk by buying an insurance policy, he overcomes his financial constraint, because by recognizing the risk, he chooses to protect himself against it, which means that a low income individual is the right person who need to be assured in comparison to the high social class that can bear the risk by themselves, revealing that rational decision-making will be so in his favor. But why in most cases this attitude is not taken, why decision making is often inappropriate, why the scientific judgment is not often applied during the reasoning and decision-making process? But what is the scientific method, what is the process of scientific thinking and reasoning? Do people use statistical evidences, surveys, primary and secondary data for solving and responding to personal and daily problems? Do people in Albanian society think and act according to scientific decision-making, thinking, reasoning, and scientific protocol? Does natural science come naturally? Is it an organized process? Why very often educated, knowledgeable and well-informed people do not use science in everyday life? Perhaps a large part of people choose to be informed by news in the media and in social networks, but they are not scientific outlets or reliable statistical institutions, they only create the illusion of being informed.

Background

According to Dunbar [2, n.d., p.1]:

Scientific thinking refers to the thought processes that are used in science, including the cognitive processes involved in theory generation, experiment design, hypothesis testing, data interpretation, and scientific discovery. Many of these aspects of scientific thinking involve cognitive processes that have been investigated in their own right, such as induction, deduction, analogy, expertise, and problem solving. Research on scientific thinking uses many different methodologies such as analyzing historical records, conducting experiments on subjects that are given scientific problems, and building computer programs that make discoveries.

According to Schafersman [3, 1994, p.1] science is:

Not merely a collection of facts, concepts, and useful ideas about nature, or even the systematic investigation of nature, although both are common definitions of science. Science is a method of investigating nature--a way of knowing about nature--that discovers reliable knowledge about it. In other words, science is a method of discovering reliable knowledge about nature. There are other methods of discovering and learning knowledge about nature, but science is the only method that results in the acquisition of reliable knowledge.

Schafersman [3, 1994] explains that scientific thinking is practiced everywhere, referring to the observation of nature and the universe through scientific methods. He emphasize that not only scientists practice it, but also anyone who uses the scientific method to observe and explore. Even when someone practices the scientific principles during his daily life for bringing knowledge and responding to the questions and problems of life and society is defined as critical thinking.

Schafersman [3, 1994, p.2) also considers that “clearly, scientific and critical thinking are the same thing, but where one (scientific thinking) is always practiced by scientists, the other (critical thinking) is sometimes used by humans and sometimes not”.

As cited in [4, 2012, p.61]:

Scientific reasoning encompasses the reasoning and problem-solving skills involved in generating, testing and revising hypotheses or theories, and in the case of fully developed skills, reflecting on the process of knowledge acquisition and knowledge change those results from such inquiry activities. Science, as a cultural institution, represents a “hallmark intellectual achievement of the human species” and these achievements are driven by both individual reasoning and collaborative cognition (Feist, 2006, p. ix).

Also in [4, 2012, p.62] is explained that:

Effective scientific reasoning requires both deductive and inductive skills. Individuals must understand how to assess what is currently known or believed, develop testable questions, test hypotheses, and draw appropriate conclusions by coordinating empirical evidence and theory. Such reasoning also requires the ability to attend to information systematically and draw reasonable inferences from patterns that are observed. Further, it requires the ability to assess one’s reasoning at each stage in the process.

According to [5, 2011, p.21] “scientific method is a methodological approach to the process of inquiry – in which empirically grounded theory of nature is constructed and verified. To understand this statement, it is useful to go back in time to see how the method evolved”.

In [5, 2011, pp.21-22] also is described that:

The origin of modern scientific method occurred in Europe in the 1600s: involving (1) a chain of research events from Copernicus to Newton, which resulted (2) in the gravitational model of the solar system, and (3) the theory of Newtonian physics to express the model. What is essentially different between the civilizations before and after the origin of science in the 1600s is a very different conception of nature. Before, nature was merely a manifestation of a supernatural – the supernatural and unobservable – the world of religion. Afterward, nature now is only what is observable in the world. Nature is thought about, described, and explained through experiments and theory and scientific paradigms. No longer do we live in a world of superstition and magic. We live in a modern world of science and technology – without magic. Modern science is both method and paradigms.

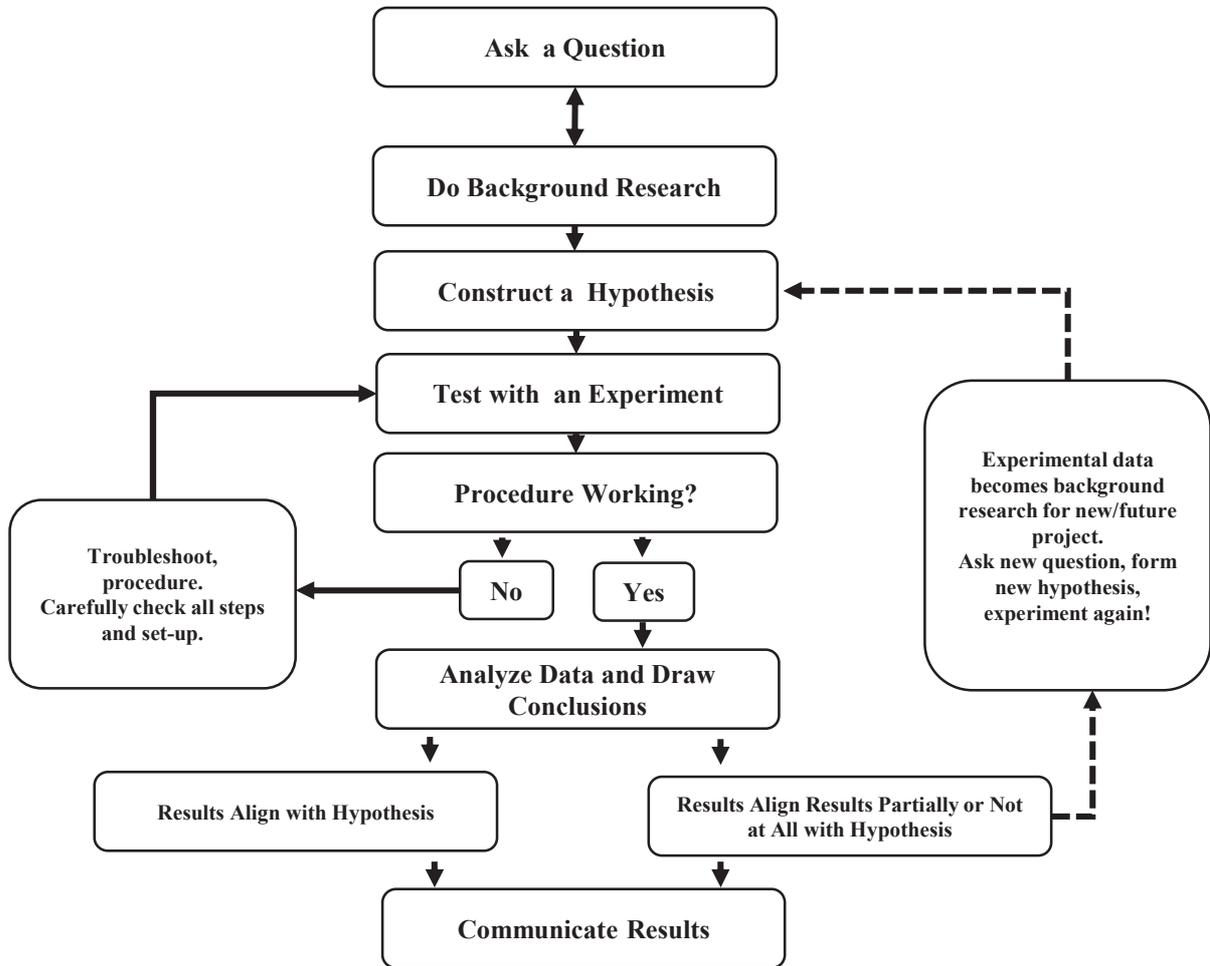
Heuristic approaches to thinking involve using rules of thumb to arrive at conclusions. Such rules of thumb are not irrational responses, as they are based upon experience, but rather, they are cognitive shortcuts that reduce the cognitive load necessary to come to conclusions (Chen, Duckworth, & Chaiken, 1999). Unfortunately, conclusions based upon these shortcuts can sometimes be inaccurate. In scientific inquiry, checking and correcting during observation and experiment are necessary to produce credible results. In science, making a correct inference requires carefully using inductive, deductive, and abductive reasoning. [6, para.1-10]

The scientific method is considered (see Figure 1):

As a process for experimentation that is used to explore observations and answer questions. When direct experimentation is not possible, scientists modify the scientific method. In fact, there are probably as many versions of the scientific method as there are scientists! But even when modified, the goal remains the same: to discover cause and effect relationships by asking questions, carefully gathering and examining the

evidence, and seeing if all the available information can be combined in to a logical answer. Even though we show the scientific method as a series of steps, keep in mind that new information or thinking might cause a scientist to back up and repeat steps at any point during the process. A process like the scientific method that involves such backing up and repeating is called an iterative process. [7, para. 3-10].

Figure 1: Steps of the Scientific Method. Source: [7]



In [3, 1994, pp. 1-2] is argued that:

Science is not merely a collection of facts, concepts, and useful ideas about nature, or even the systematic investigation of nature, although both are common definitions of science. Science is a method of investigating nature--a way of knowing about nature--that discovers reliable knowledge about it. In other words, science is a method of discovering reliable knowledge about nature. Reliable knowledge is knowledge that has a high probability of being true because its veracity has been justified by a reliable method. Reliable knowledge is sometimes called justified true belief, to distinguish reliable knowledge from belief that is false and unjustified or even true but unjustified. Every person has knowledge or beliefs, but not all of each person's knowledge is reliably true and justified. In fact, most individuals believe in things that are untrue or unjustified or both: most people possess a lot of unreliable knowledge and, what's worse, they act on that knowledge! Other ways of knowing, and there are many in addition to science, are not reliable because their discovered knowledge is not justified. Science is a method that allows a person to possess, with the highest degree of certainty possible, reliable

knowledge (justified true belief) about nature. The method used to justify scientific knowledge, and thus make it reliable, is called the scientific method.

Study Design

This preliminary study has a qualitative empirical approach, so it does not intend to test some hypotheses to conclude and generalize results for a large population, but only aims to explore the critical thinking of the citizens in everyday life. The main purpose of the study is to generate an understanding of how close the scientific thinking is the individual in his way of acting, thus discovering a general idea about the tendency of thinking, attitude, behavior, action or decision-making of people in everyday life, to answer the main question of the study:

"Do people apply scientific thinking in everyday life?"

Based on the data, the study revealed that Albanian well educated population applies in its attitude and decision-making in everyday life the principles of critical thought and scientific method. The research type of this study is mainly explorative and descriptive, referring to the characteristics of these two types of research as it is explained in [8, 2014].

The main instrument of the study and data collection has been a short questionnaire with some questions about demographic data of the study sample, but considering in focus the main question of the study. The study is based in a non-probability sampling techniques, defined as convenience sampling, therefore the sample of the study is selected through an on-line questionnaire. Before that the respondents have participated in the survey, the data collection instrument or the questionnaire is preliminarily tested on a small pilot sample to test its comprehensiveness and its validity. The data of the study have been collected over a quarterly period, and then are processed and analyzed through descriptive statistics to come up to the main finding of the study to answer the main question of the study as well as to develop an idea that can be translated in a possible hypothesis for a quantitative study in the future.

Data Analysis and Findings

The labor force statistics reveal that the age group 15-64 years occupies almost 97% of the labor force, while 81% of the workforce age group 15-64 years is most likely to have secondary education [9, 2016]. This means that these individuals do not have in-depth knowledge of the various scientific theories, which will be reflected in the productivity and quality of their performance not only at work but even in everyday life. So, we must say that their decision making misses the critical scientific thinking. The sample of this preliminary study consisted of 100 valid questionnaires. After collecting and analyzing the empirical data, in the following are presented the main characteristics of the study sample:

- The average age of the respondents was 26 years, while the respondents' age range was 18-45 years.
- Regarding the level of education 100% of the respondents have completed bachelor program, about 68% of respondents were attending a bachelor or master program, 5% already have a Ph.D., and 19% had already completed a master program.
- Referring to their profession, almost 27% of the respondents worked in the field of accounting and finance; while 11% of the sample worked as teacher, professor and researcher; the rest of the sample worked in sales, banking, owns a small business, in public administration, as waiter, teller, lawyer, student, manager, or were unemployed.

- Also 74% of the sample were female and 26% male.
- Most of the respondents lived in the cities of Vlora and Fier, 57% and 15% respectively.
- Most of the respondents, nearly 73% were unmarried, and live close to their parent's family.

Besides the demographic data, the questionnaire has intended to guide and collect key data through a single main question. The main question of the questionnaire was about a real situation, so the respondents were introduced with a model of application of scientific method and critical thinking in everyday life, a simple model to explore the individual's latent behavior in decision-making in his daily life, as suggested in [10, 2015], and in accordance with the objectives and the purpose of the study.

The main question of the study questionnaire is presented in the following:

Situation: As soon as you enter the house tired after a long working day, you try to turn on the corridor lamp but it does not work (or does not light up). On a scale from 1-5, how do you agree, that about this problem you will judge quickly and default in accordance with the model below.

The way you judge

1. Observation: The light bulb did not light.
2. Question: Is the light bulb burned out?
3. Hypothesis: The light bulb is burned out.
4. Prediction: If I replace the bulb and it lights, then my hypothesis is validated.
If the bulb does not light, then my hypothesis is invalidated.
5. Experiment: Replace the bulb.
6. Result: New bulb lights up.
7. Conclusion: My hypothesis is validated. The bulb was burned out.

1	2	3	4	5
Strongly disagree	Disagree	Neutral	Agree	Strongly agree

Referring to this question, the survey data reveal that 83% of the sample have responded that 'agree and strongly agree' regarding the application this procedure during their decision-making on a daily life problem. So we must emphasize that the question above reveal the scientific method steps, which means that the results above show that highly educated people in Albania use scientific thinking as a basis in their day-to-day decision-making.

Conclusion

This study can be classified as a modest empirical study on the field of scientific thinking. The nature of the study was mainly investigative, so it is not an inferential study because it did not aim to test hypothesis and generate conclusions about them. Obviously, the main finding of this preliminary study will be formulated in the future as a main hypothesis of a quantitative study

that will consider a large number of independent or moderate variables such as demographic, cultural, psychological, educational, and definitely many other variables, since the topic of this study is interdisciplinary and moreover scientific theory and science is worthy for everyone. Some societies fear science, but exactly for this reason they must apply scientific process steps in everything they encounter. Despite the data of this study, considering our experience as business school professors we suggest that scientific method and critical thinking must be applied as a subject in all levels of education even in primary and secondary education, because only this way the society will guarantee the development of the scientific method and scientific thinking in each of its step, considering even the actions and personal decisions of the people that make it up. The main constraint or limitation of the study is its sample, referring to the selection of a highly educated sample that even confirmed traces of scientific thinking in everyday life.

However, future studies should be made, considering even other latent questions as well as a probability sampling method.

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