REFLECTING ON THE AIM, GROWTH AND RATIONALITY OF SCIENCE IN KARL POPPER

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ABSTRACT
In his falsification theory, Karl Popper highlighted the aim, growth and rationality of science. Little wonder he emphasized that falsification aims to demarcate science from non-science or pseudo-science as he called it. He reasons are encapsulated in what he termed rationality of science which incorporates the aim and the mode of growth of science. This paper adopts the philosophical method of analysis to examine the concepts of the aim, growth and rationality in science. The paper argues that the aim, growth and rationality of science gave rise to Popper underscoring the need for objectivity in science, conjectures and explanations as well as verisimilitude, as these are the basics for understanding the aim of science, the procedure of growth of science and the rationality that defines science. The paper, therefore, concludes that Popper's falsification and demarcation theories were designed to make explicit the aim of science, the process of growth in science and the rationality that is embedded in scientific endeavours.

KEYWORDS: Growth, Rationality, Science

Introduction: On the Aim and Growth of Science

Regarding the growth of science, Popper maintains that "within the field of science, we have a criterion of progress."[1] This progress, for him, is progress from problems to problems. Thus, for Popper, "science starts from problems, and not from observation; though observations may give rise to a problem, especially if they are unexpected; that is to say, if they clash with our expectations or theories."[2]
He further posited that:

> We may say that most lasting contributions to the growth of scientific knowledge that a theory can make are the new problems which it raises, so that we are led back to the view of science and the growth of knowledge as always starting from, and always ending with problems -problems of ever increasing depth, and an ever increasing fertility in suggesting new problems.[3]

When Popper speaks of science starting from problems, he means that problems are the igniting force of science. That is to say that those problems give rise to scientific theories. That explains why he presented satisfactory explanations as the aim of science. These satisfactory explanations are here looked upon as scientific solutions to problems which science sees as its aim to solve. For Popper, these satisfactory explanations or solutions do not come in a straight line; rather they come in some sort of dialectic manner. For him, science progresses by means of conjectures and refutations; we make bold conjectures that are as testable as possible and unfailingly find them wanting so that they are refuted and new conjectures are formulated. This way, hypotheses are counted as scientific only if they are falsifiable. That is why Popper explicates that "in science, more often than not, scientists put forward statements and conduct step by step testing. Thus, in the field of empirical sciences, more particularly, he (the scientist) constructs hypotheses or systems of theories, and tests them against experience by observation and experiment."[4]

In his *The Structure of Scientific Revolutions,* Kuhn speaks of Normal science as a puzzle-solving enterprise; he looks at normal science as an enterprise that seeks to solve a puzzle (problem) in the field of knowledge. It is of great interest to note that what Kuhn refers to as 'Normal Science' is what Popper strictly calls 'Science' as against pseudo-science. Popper appropriately demarcates both through falsification which enables an empirical or scientific system be refuted by experience. Just like Popper holds that there is a criterion of progress in science, Kuhn also holds that progress in science is not a simple line that leads to the truth. Instead, it is a more progress away from less adequate conceptions to more and better conceptions about the world. It is in that way that new theories are built upon previous ones. Kuhn, accordingly, cited The *Copernican Revolution* as example of revolution in science.

In fact, the crux of Kuhn's position is that scientific progress comes by means of revolution. This revolution comes by way of what Kuhn calls paradigm shift. In the work of Kuhn, paradigm could be seen as an exemplar, which is the very best among examples. It can also be seen as a model, a pattern or a template. Examples of such paradigms in science are: laws, theories, applications, experiments, etc. In the progress of science, each paradigm becomes the

first port of call before a superior paradigm takes over. Thus, "Normal science is characterized by a paradigm, which legitimates puzzles and problems on which the community works."[5] Of course, Kuhn holds that paradigm change has a procedure: "What is the process by which a new candidate for paradigm replaces its predecessor? Any new interpretation of nature, whether a discovery or a theory, emerges first in the mind of one or a few individuals".[6] This is very similar to Popper's idea of rationality of science or what he (Popper) refers to as critical rationality in science. Recall that the aim of science according to Popper is satisfactory explanation about problems of the universe. What Popper refers to as explanation is what Kuhn calls interpretation which according to him (Kuhn) emerges first in the mind of one or a few individuals. This interpretation which starts first in the mind of a few individuals according to Kuhn is what Popper calls bold conjecture or critical rationality. Thus, according to Popper, "the scientist constructs a hypothesis or systems of theories, and tests them against experience by observation and experiment"[7]. This process is called falsification in science in the language of Popper and revolution in the language of Kuhn. However, it is pertinent to note that the two concepts are tilting towards one goal which is to bring out the best in science. Therefore, both Popper and Kuhn have a similar conception of science. This conception is viewed as purist vision of science.

In the history of the Philosophy of science, we find also other important contributions that portray science in a very different way. In his book *Against Method*, Paul Feyerabend attacked the rationalist account of scientific method which eulogizes the search for a system of rules that should guide scientists in generating scientific theories. For him, therefore, science does not have a specific method so that any tradition that can lead to knowledge should be encouraged and adopted in science. As a matter of fact, he argued for proliferation of theories as a means of making progress in science. Little wonder he opines that "variety of opinions is necessary for objective knowledge".[8] For him, relying on method inhibits progress in science. Just like Popper, Feyerabend rejected induction as a method in science on the assumption that "induction is insufficient because it is bound to eliminate ideas simply because they do not fit into the framework of some older cosmology, but proliferation of theories leads to development of counter induction which is both a fact and is needed much more in the game of science".[9]

Again, like Popper, Feyerabend holds that the task of science is to give us a correct account of the world. This is what Popper calls satisfactory explanation about the world. Therefore, both Popper and Feyerabend believe that science has aim and a goal which is to provide a correct account or satisfactory explanation about the world. However, their point of difference lies in the method of reaching to the aim of science; while Popper had propounded falsification as a method in science, Feyerabend submits that science has no method. Instead, he (Feyerabend) projects "subjective wishes" of individuals as a way forward for growth and progress in science. These subjective wishes make it possible for different individuals to exhibit freedom in the scientific enterprise. However, an analytic look at the subjective wish of Feyerabend will reveal a point of convergence with Popper's idea of conjecture; in conjecture the individual has freedom to make a guess. However, at this level of conjecture, science is not yet born just as it is in the subjective wish of Feyerabend. That is to say that science comes to being when the conjecture of Popper assumes an objective status and also when the subjective wish of Feyerabend translates to objectivity.

On his own part, Imre Lakatos, could be regarded as one of the philosophers of science who, through his methodology, sought to engage in rational reconstruction of science. His methodology runs in contrast to the methods put forward by his predecessors, namely: Popper, Kuhn and Feyerabend. However, it cannot be said that he did not borrow some ideas from them; he adopted both Popper's falsification and Kuhn's paradigm shift. Imre Lakatos stated in his work that:

> According to my methodology the great achievements are research programmes which can be evaluated in terms of progressive and degenerating problem shifts; and scientific revolutions consists of one research programme superseding (overtaking in progress) another. This methodology offers a new rational reconstruction of science. It is best presented by contrasting it with falsificationism and conventionalism, from both of which it borrows essential elements.[10]

In his *Methodology of Scientific Research Programmes*, he expresses a radical view of Popper's criterion of demarcation between science and non-science and argues that "the problems of methodological falsification (Popper's falsification) are: that we have no means to judge whether the theories of our successive theories decrease or increase and that methodological falsification lacks history of science"[11] Lakatos' criticism against Popper's falsification has no bearing because the whole corpus of Popper's falsification is to demarcate science from non-science or pseudo-science.

Therefore, if falsification of a statement or systems of statements is successful, then scientific progress is made. If otherwise, there is no science. So which other means of measuring the success of a scientific theory could be better

than this? On the contrary, Lakatos' position could be perceived more as a support to Popper rather than an attack. After all, he (Lakatos) posited that "a research programme is successful if it leads to a progressive problem shift and unsuccessful if it leads to a degenerating problem shift".[12] What more can be said about the similarity between Popper's Falsification and Lakatos' Methodology of Scientific Research Programme?
At this point, we recall that Popper's idea of the aim and growth of science flows in the theories of all the philosophers of science that came after him. His Falsificationism aims to perfect the explanatory powers of systems of statements about the universe in such a way that we can arrive at satisfactory explanations about the universe which is his aim of science. Thus, falsification makes it possible for the aim of science to be well achieved which is for better scientific theories to emerge.

Objectivity and Rationality of Science

There is no doubt that science is an objective enterprise. This is because it is public knowledge as against individual knowledge or information. Consequently, it is essential that in science, that the information about the object of study is accurate and reliable and therefore as objective as possible. The talk of science being objective is science not being influenced by human emotions, biases and prejudices. It is good to mention this because science being an empirical endeavour emanates from observations. Observations, in themselves are done by means of human senses such as senses of vision, taste, hearing, smell etc. Because our senses may differ from person to person, there is every indication that scientific objectivity is not guaranteed were science to rely on human senses alone.

For Karl Popper, the question of objectivity in science must not be swept under the carpet. This is so because, as has earlier been mentioned, science takes off from observations which are done by the senses. Thus, what we have at this level could be likened to personal feelings or personal convictions. However, science is not the same as personal conviction because personal convictions are not sufficient to justify a statement. Therefore, scientific statements or theories should not be accepted based on personal convictions as they are at variance with scientific objectivity. Expatiating on this in his *Logic of Scientific Discovery*, Popper notes that:

> Even the fact, for me so firmly established that I am experiencing this feeling of conviction, cannot appear within the field of objective science except in the form of a psychological hypothesis which, of course, calls for inter-subjective testing: from the conjecture that I have this feeling of conviction the psychologist may deduce, with the help of psychological and other theories, certain prediction about my behaviour, and these may be confirmed or refuted in the course of experimental test.[13]

The implication of the above postulation of Karl Popper is that no matter the level of one's feeling of conviction about a particular statement or statements, it cannot constitute the ground for its acceptability and justifiability as scientific statement or statements. This is because such a statement lacks merit when placed in the scale of scientific objectivity. For scientific statements to be objective means that they have to pass through inter-subjective testing. For Popper, "inter-subjective testing is an aspect of all the all-embracing idea of inter-subjective criticism or what may be called mutual rational control by critical discussions"[14]. This way Popper believes that the talk of objectivity of scientific statements lies in the fact that they can be inter-subjectively tested.

At this point may it be stressed that the question of inter-subjective testing of theories as Popper would have it has its root in falsification. In itself, falsification aims at bringing about objectivity of scientific statements or theories. Thus, Popper's insistence on testing is designed to highlight the necessity that should greet every scientific statement to be capable of being tested so that there will not be any statement in the terrain of science that is accepted as true on the basis of sounding convincingly true but without appropriate testing.

In Philosophy of Science, objectivity is understood as the concept of truth that is independent of individual subjectivity, bias, prejudice, judgment, etc. Therefore, something is objective when its judgment is based on observable phenomena that is uninfluenced by emotions or personal prejudices. It is in the same vein that Popper underscores objectivity in science as that which "indicates that scientific knowledge should be justifiable, independently of anybody's whim: a justification is objective if in principle it can be tested and understood by anybody".[15] Therefore, objectivity in science simply means that scientific statements exist independently of individuals' perceptions or conceptions. Scientific statements are not to be distorted by emotions or personal bias. Here we see that science is demarcated from non-science based on objectivity and subjectivity. Thus, whereas science thrives in objectivity, non-science is enshrouded in subjectivity.

For clarity's sake, may it be highlighted that subjectivity refers to what is belonging to, proceeding from or relating to or emanating from a person's emotions, prejudice, sentiments, etc. This explains why subjective information usually consists of judgments, assumptions, beliefs, suspicion, rumour, etc. As a corollary, subjective information can vary from person to person and so it can be far away from the truth. On the contrary, objective information does not vary and it is close to the truth. Based on the foregoing, some statements of suit Sayers, diviners, astrologers, etc,

are not to be counted as scientific on the basis of them lacking in objectivity. Therefore, it is here succinctly clear that the talk of scientific progress is the talk of search for objectivity. Thus, without objectivity, there is no science. That explains why Karl Popper expressed that scientific knowledge should be independent of any body's whims, prejudice, bias and perception. Scientific knowledge is equal to objective knowledge even though for Popper it may emanate from individuals perceptions or perspectives in the form of conjectures but it is not to stop at the level of conjecture. For Popper, conjectures are made and falsified for the sole purpose of scientific progress which in turn is the search for scientific objectivity. However, when conjectures are made and they do not pass falsifiability test, they are jettisoned on the ground of not being scientific. Thus, in Popper's Philosophy, falsification aims towards scientific objectivity just as scientific objectivity is a product or outcome of falsification.

Conjectures and Explanations and Rationality of Science

The two major issues of attention in Popper's Philosophy of Science are his rejection of induction as a method in science and propounding of falsification in science. For him "all human knowledge is fallible and conjectural … a product of the method of trial and error".[16] In Popper's submission, scientists bring forth bold conjectures for trials and then carry out systematic falsification of those conjectures. In Popper's argument, for a proposition, statement or hypothesis to be counted as scientific it must be found to be at risk of making some predictions. This is what Popper calls bold conjectures. Furthering his submission, he succinctly states that "statements or systems of statements, convey information about the empirical world only if they are capable of clashing with experience; or more precisely, only if they can be systematically tested, that is to say, if they can be subjected to tests which might result in their refutation.[17]

In Popper's understanding of science, the duty of the scientist is to make a conjecture and try to refute it. For him therefore, making conjectures and falsifying them should be the real route of science. Therefore, scientific statements or propositions should be exposed to the risk of being falsified by way of subjecting them to severe tests. Popper explains that the greater the severity of the various tests, that the proposition has successfully endured the higher the degree of carroboration".[18] What this implies in Popper's parlance is that well tested theories can as well remain merely provisional and therefore, can be rejected following an experimental result that runs contrary to its predictions or conjectures. About this, Popper's remark is that "scientific theories are either falsified or forever remain hypothesis or conjectures".[19]

In Popper's philosophy of science, conjecture and explanations or rather better explanations are intertwined. This is so because he believes that our desire for knowledge is linked to our desire for finding solutions to some problems. Thus, in the quest for knowledge for problem solving explanation are needed and indeed not just explanations but better explanations at every point in time. However, in the process of looking for explanation sometimes we ordinarily and already possess some forms of explanations which might have come by way of hazarding a guess or speculation. This is what Popper termed bold conjecture. But the already made explanation as the case could be inadequate to deal with the problem solving, hence the need for better explanations that surpass what is currently at hand. More still, these better explanations can still be expected to birth better and better explanations. In analyzing Popper, Danny Frederick in his article – *Karl Popper: Conjectures and Refutations*, reeled out some conditions of better explanations by stating that an explanation is better than another if:

i. It is falsifiable while the other is not.
ii. It explains what the other explains and some other things better.
iii. It provides a unified solution to problems that were explained in different ways by the other.
iv. It generates surprising falsifiable predictions that are not derivable from the other and those predictions survive testing.
v. It corrects the other, that is, it shows that some falsifiable predictions of the other that were thought to be successful were actually not successful and it explains why they seemed successful.

This is a thorough representation of Popper's evolution of better explanations that emanate from conjectures. This is so because in Popper, we learn that for us to get better explanations we should expound conjectures and then subject them to criticism. When this is done, poorer explanations should be jettisoned in favour of better explanations.

Theory of Verisimilitude and Rationality of Science

Etymologically, the term - *verisimilitude* is a derivation of Latin term – *verisimilitude.* Dissection of the term takes us further to the origin which are 'verus' - 'true' and 'smilis' – 'like'. The 'veri' in 'verisimilitude' is the genitive case of 'verus'. Thus we now have 'veri' and 'similis' which are 'of true' and 'like' respectively. Therefore, the concept of verisimilitude would translate to English as 'truthlikeness'. This is not different from its Greek equivalent – 'eoikotos' which in English means – 'like the truth'.This study will consider the concept of verisimilitude in Karl Popper's Philosophy of Science. It may sound contrasting to state that Popper believes that science does not ultimately seek after unraveling of truth. At best, it is the position of Karl Popper, after all, his theory of verisimilitude suggests that science in its move to explain reality as it relates to truth, can only try to come near to the truth. That simply means that science in its endeavor can only achieve truthlikeness. However, this does not take

away the objective nature of science. After all, Popper's theory of falsification stipulates that the search for the truth is an ever-continuous exercise. This implies that no theory in science can actually claim finality.

And for Popper, that spells progress in science. In explaining out the nexus between verisimilitude and objectivity, Popper portrays that:

> The status of truth, in the objective sense, as correspondence to the facts, and its role as a regulative principle, may be compared to that of a mountain peak wrapped in clouds… A climber may not merely have difficulties in getting there – he may not know when he gets there, because he may be unable to distinguish, in the clouds, between the main summit and a subsidiary peak… yet this does not affect the objective existence of the summit; and if the climber tells us 'I doubt whether I reached the actual summit', then he does, by implication, recognize the objective existence of the summit … the very idea of error or of doubt (in its normal straight forward sense) implies the idea of an objective truth which we may fail to reach. [20]

The above outlined expatiation of Popper reveals how arduous and enduring the trajectory of truth could be. In his theory of conjecture we see how the search for truth begins from opinion (bold conjecture). As a matter of fact, Popper is not the first to offer this kind of explanation with regard to quest or search for truth. In his own right, Plato stated that "we, for the most time, live in the twilight zone between knowledge and ingnorance."[21] In a similar vein, Plato was quoted as having put forward the following lines below:

> It is wisdom judging things correctly without being able to give a reason … surely you see that this is not the same as knowing – for how could knowledge be unreasoning? And it's not ignorance either – for how could what it's the truth be ignorance? Correct judgment, of course has this character: it is in between understanding and ignorance.[22]

What the above lines portray is that there is no absolute or final truth in any understanding of the truth content of any concept. On his own part, Popper is of the opinion that whatever the case, that we must not remain static. Instead, we must make progress because it is that way that scientific progress is assured. Therefore, for there to be progress in scientific knowledge, the scientist must critically engage in testing of already available theories in order to decipher a greater nearness or closeness to truth. This nearness to truth simply implies acceptance at any point in time of a scientific theory with greater explanatory power. This is so because Popper believes that every scientific theory is a response to a scientific problem which in turn is linked with discovery of an explanation. The theory of verisimilitude brings out the non-finality and fallibility of scientific theories. But Popper did not want to give in. That is why with his theory of verisimilitude he sounds very much hopeful that scientists can still get closer to the objective truth so much so that scientific progress is very much possible. Shedding light on this, Popper postulates thus:

> Looking at the progress of scientific knowledge, many people have been moved to say that even though we do not know how near to or how far from the truth we are, we can, and often do approach more and more closely to the truth… I myself have sometimes said such things, but always with a twinge of bad conscience … But as long as we speak as clearly as we can, yet do not pretend that what we are saying is clearer than it is … there is no harm whatever in occasional vagueness, or in voicing every now and then our feelings and general intuitive impressions about things.[23]

The above position of Popper leads us to understand verisimilitude as an approximation to truth which means that every sincere search for truth portends getting closer to the truth.

CONCLUSION

Karl Popper was a critical rationalist. As such he was very much opposed to all forms of skepticism, conventionalism and relativism in relation to science. For him, this defines the progress and rationality in scientific process. As a matter of fact, in his book, *The Logic of Scientific Discovery*, he channeled his argument against the members of Vienna circle and their logical positivism that only affirmations of factual matters of logical relationship between concepts are significant. For Popper, the pivotal issue in the Philosophy of science is the question of demarcation that explains the distinction between science and non-science. Popper made this distinction to portray that rationality that drives growth in science. In analyzing Popper's brand of demarcation, David Miller posits that "any demarcation in my sense must be rough. For the transition between metaphysics and science is not a sharp one: what was a metaphysical idea yesterday can become a testable scientific theory tomorrow and this happens frequently".[24]

Thus, Popper was very particular and specific on the kind of demarcation he sought to expound, namely, demarcation between science and what he calls non-science. This is in contrast with verification principle that seeks to eliminate metaphysics. As a way to further drive home his point, Popper expatiates that:

> There will be well-testable theories, and non-testable theories. Those which are non-

> testable are of no interest to empirical scientists. They may be described as metaphysical. Here I must again stress a point which has often been misunderstood. Perhaps, I can avoid these misunderstandings if I put my point now in this way. Take a square to represent the class of all statements of a language in which we intend to formulate as sciences, draw a broad horizontal line, dividing it into an upper and half; write 'science' and 'testable' into the upper half, and 'metaphysics' and 'non-testable' into the lower: then, I hope, you will realize that I do not suppose to draw the line of demarcation in such a way that it coincides with the limits of a language, leaving science inside, and banning metaphysics by excluding it from the class of meaningful statements.[25]

The point Karl Popper is making is that it is important to solve the problem of metaphysics from science but not in the approach of the members of Vienna circle. This is because some metaphysical systems have actually metamorphosed into vital scientific results. Having opposed verficationism, Popper projects falsification as a method of scientific enquiry. This for him is capable of according to science the rationality it deserves. Accordingly, he posits that a theory is scientific only if it is falsifiable by a conscious effort. "Popper's theory of demarcation is based on his perception of the logical asymmetry he has between verification and falsification: it is illogically impossible to definitively verify a universal proposition by reference to experience (as Hume says), but a single counter –example refutes definitively the corresponding universal law".[26] The criterion of demarcation between science and non-science in Popper portrays a true scientific theory as restrictive in the sense that it can be tested and falsified as against non-science which bears the opposite attribute. This way, Popper believes that he has attempted to address the question of the aim, growth and rationality in science.

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