IGWEBUIKE: An African Journal of Arts and Humanities. Vol. 8. No. 2, (2022)
ISSN: 2488- 9210 (Print) 2504-9038 (Online)
Department of Philosophy and Religious Studies, Tansian University, Umunya

INDUCTION VERSUS SCEINTIFIC PROGRESS: EXAMINING BACKGROUND QUESTIONS IN POPPER'S CONCEPTION OF SCIENCE

Charles Kosolu Onebunne
Department of Philosophy, Nnamdi Azikiwe University, Awka
ck.onebunne@unizik.edu.ng
&
Prof. Bonachristus Umeogu
Department of Philosophy, Nnamdi Azikiwe University, Awka
bu.umeogu@unizik.edu.ng
DOI: 10.13140/RG.2.2.33912.11529

Abstract
Induction has been viewed as a scientific method. That is to say that scientific hypothesis, theories and laws are arrived at by means of induction. But induction has its problem; the problem of justifying the inductive inference from the observed instances to unobserved instances. This is the problem of hasty conclusion. Thus, in induction, the inference is rationally unjustified. This explains why the truism of induction as a method of science was challenged by Karl Popper who contended that induction by its very nature cannot bring about progress in science even as it cannot really enable us demarcate what is scientific from what is not. In contrast, Popper propounded his famous theory of falsificationism where he asserts that the criteria of the scientific status of a theory are its falsifiability or refutability, or testability. In this way, Popper believes that progress in science would be achieved. This study employs the method of analysis to bring to the fore, the problems associated with induction and which have prompted and propelled Popper's conception of science. This study reveals that, for Popper, induction is not capable of assuring progress in science.
Keywords – Induction, Scientific Progress, Falsification.

Introduction

From time immemorial, science and scientific theories have been in progress. This is so because since the creation of the universe mankind has been faced with multifaceted problems that require authentic solutions. To this end, many theories have kept on springing up in other to proffer solutions to those problems. Put in another way, so many discoveries have been made, all in a bid to take care of problems of mankind. However, these discoveries have given rise to such problems as; how do we account for scientific discoveries? What method leads to

scientific discoveries? How do we account for the truth and certainty of these discoveries?

Owing to the above questions, some answers have emerged by way of ideologies. In the first instance, instrumentalists would deny the position that scientific theories about unobservable can be accepted as the description of an observable world. This implies that for them, the world is an experiential world so that any description of it must be experimental too. In their own postulation, the realists have it that science seeks to explain and understand nature in a way that theoretical entities are postulated in form of a scientific theory to explain the reality of observable phenomena. On their own part, the relativists would make us believe that there is no such thing objective truth because for them, truth depends on the community that claims it. This relativistic conception is rather problematic because it implies that there is no objective body of science.

Incidentally, it is in given to these various conceptions of science and the problem they generate that serve as the background of this study. Consequently, this study focuses on Karl Popper's Falsification where he proposed that science relies on putting up a hypothesis by way of conjecture and then falsifying it. According to Popper, so long as a hypothesis is falsifiable, near - objectivity of science is assured. This is against the earlier held belief by some philosophers of science that induction is the traditional method in science and remains so. It is against this background that this study seeks to put induction and scientific progress side by side to actually see if induction as a method in science can bring about real progress in science. Of course, for Popper, induction cannot offer real progress in science. This is the key background problem that informed his conception of science which is rooted in his falsificationism whereby falsificationism is seen not as an aberration to scientific endeavour, but as an innovation and a revolutionary endeavour. As a matter of fact, falsification in itself is a pointer to the fact that no knowledge is final. This means that for Popper, falsicationism as a method gives room for progress in science as against induction which, as it were, is not capable of assuring progress in science.

Popper on the Problem of Induction

One of the major issues in Philosophy of science has always been the methodological approach to science. As it were, all through the history of science, induction has been considered to be a method in science by some philosophers of science. However, popper, did not see induction as a veritable method in science.

In the light of this, he (Popper) aligned himself with Hume's refutation of induction as a true method of acquiring knowledge. In the same veins, he argues that Bacon's system of induction in itself is naive and as such cannot stand as scientific method.

However, some scholars are of the opinion that Popper's rejection of Bacon's induction is as a result of him not properly comprehending Bacon's position. This is because Popper shares same view as Bacon that science is distinguishable from non-science by its empirical method which is basically inductive. Nonetheless, Popper was not comfortable with inductive method whose inferences have observations as premises and theories as conclusions. This did not go down well with Karl Popper. Instead, Popper believes that Hume's rejection of induction is lucid enough. It was Hume who posits that our assumptions of cause and effect in relation to two events cannot be necessarily true. For Hume, that is causal connection which in itself is assumption that is not subject to reason. Hume went further to assert that what is normally termed causal connection is simply as a consequence of repeated observations about two events. Thus, for Hume there is no real rational support to believe in causation.

Popper argues that scientists hold onto induction because they suppose that it is only induction that can provide a definitive criterion of distinction between science and non-science. For Popper, it is not to be so because the real procedure of science is to operate from conjectures. Induction can simply be described as the process of constructing a general law from observation of particular instances. For Popper, it is not to be accepted in the terrain of Science. In his rejection of induction he puts it succinctly that "for any conclusion drawn in this way may always turn out to be false: no matter how many instances of white swans we may have observed, does not justify the conclusion that all swans are white".[1] With this, the problem of induction becomes whether inductive inferences are justified, and under what conditions they are justified. Popper sees the principle of inductions as lacking the purely logical truth and therefore contains logical inconsistencies.

According to Popper, that inconsistencies can easily come up from the principle of induction is very clear in David Hume's *An Enquiry Concerning Human Understanding*. However, Popper argued that Hume ran into the same error that he tried to refute when he admitted the principle of induction, albeit psychological.

In his look earlier mentioned, Hume had argued that "even after the observation of the frequent constant conjunction of object, we have no reason to draw any inference concerning any objects beyond those of which we have had experience"[2]. In another line Hume submitted thus: "I would renew my question, why from this experience we form any conclusion beyond those past instances, of which we have had experiences."[3] This goes to demonstrate that justifying induction by relying on experience leads to infinite regress. Popper found Hume's critic of induction to be correct and conclusive, but was dissatisfied with his psychological explanation of induction as habit or custom.

This is on account of Hume's theory giving a causal explanation of a psychological fact that is "the fact that we believe in laws, in statements asserting regularities or constantly conjoined kinds of events."[4] Again, it implies that "through custom and habit we are conditioned by repetitions and by the mechanism of the association of ideas, a mechanism without which Hume says we could hardly survive"[5].

At this point it is clear that Popper sees induction as any method of showing to be true general laws on the condition of observational data or information. It is however noteworthy that Popper does not disagree with the assumption or belief that scientists could state general laws by way of testing these general laws against observational data. Instead Popper, as Hilary Putnam puts it in his article – *The Corroboration of Theories,* proposed his theory of corroboration saying that when scientists corroborate general law that they do not in that way assert the laws to be true or even probable.

Popper on Deductive Testing of Theories

"Popper argues that the only logical technique that is integral part of the scientific method is that of deductive testing, the conclusions being deduced from a hypothesis and then compared with each other and other relevant statements to determine whether they falsify or corroborate the hypothesis"[6] In supporting the position of Karl Popper, Thornton posits that "Such conclusions are not directly compared to facts, simply because there are no 'pure' facts available; all observations statements are loaded by theory and are just as much a function of purely subjective factors (interests, expectations, desires, etc) as they are a function of what is truly objective"[7] still furthering his contention regarding deductive testing, Popper went ahead to specify four steps for his deductive procedure:

> I proposed that the refutability or falsifiability of a theoretical system should be taken as the criterion of its demarcation. According to this

> view, which I still uphold, a system is to be considered as scientific only if it makes assertions which may clash with observations, and a system is, in fact, tested by attempts to produce such clashes, that is to say by attempts to refute it. Thus, testability, is the same as refutability, and can therefore, likewise be taken as a criterion of demarcation. There are, moreover (as I found later), degrees of testability: some theories expose themselves to possible refutations more boldly than others.[8]

It is the conviction of Popper that the philosophy of Hume has really portrayed that there is an inherent contradiction in traditional empiricism that claims that all knowledge derive from experience and that universal sentences, which includes scientific, laws, can be verified by having recourse to experience. Contradiction derives from the attempt to show that, despite the openness of the experience, scientific laws can be interpreted as empirical generalizations, which in a way finally confirm a positive experience. "Popper eliminates the contradiction by rejecting the first of these principles and eliminating the imposition of empirical verification into falsifiability in the second principle".[9]

In the foregoing, Nicolae sfeteu said of Popper that:

> Scientific theories are not inductively deduced from experiences nor are scientific experiments conducted to verify or establish their truth, all knowledge is provisional, conjectural, and hypothetical – we can never prove theories definitely, we can only confirm (temporarily) or refute them. That is why we have to make a choice between theories that explain the set of investigated phenomena, eliminating only those theories that are falsified, and rationally choose between the remaining unfalsified theories, the one that possess the highest level of explanatory power and predictive power.[10]

This way, "Popper emphasizes the importance of the critical spirit of science – critical thinking is the very essence of rationality".[11]

Popper on Demarcating Science and Non-Science

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. 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. "Logical positivism, through the theory of verificatiionism, considered that only affirmations of factual matters of logical relationship between concepts are significant".[12] However "the verificationist proposals had the aim of solving a distinctly demarcation problem, namely that between science and metaphysical".[13]

For Popper, the pivotal issue in the Philosophy of science is the question of demarcation that explains the distinction between science and non-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".[14]

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 principles 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 supposed 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.[15]

The point Karl Popper is making is that it is important to solve the problem of demarcation of metaphysics from science but not in the approach the members of Vienna circle. This is because some metaphysical systems have actually metamorphosed into vital scientific result.

Having opposed verficationism, Popper projects falsification as a method of scientific enquiry. 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".[16] 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.

There is no gain saying the fact that Popper uses falsification as a demarcation criterion for evaluating theories as to which ones are scientific and which ones are not. In the postulation of Nicolae Sfetcu, "the Popper criterion does no exclude from the field of science, statements that cannot be falsified, but only theories that contain no falsifiable statement".[17] The reason why Popper sought to write elaborately on his brand of demarcation is as a result of his observation that members of the Vienna Circle in their verificationism, were mixing two different concepts, namely, the question of significance and the question of demarcation. "Verificationism claims that a statement must in principle, be empirically checked to be both meaningful and scientific"[18]

For Popper, those concepts are two different things. In this light, "Popper said that there are significant non-scientific theories, and therefore a significant criterion does not coincide with a delimitation criterion proposing replacing verifiability with falsifiability as a delimitation criterion"[19]

In a nutshell, Popper "opposed the view that statement that are not falsifiable are meaningless of wrong".[20] With this, it becomes clear that Karl Popper does not dismiss non-scientific theories as they could possess their own meaning and as well could become raw materials for scientific theories.

Falsifications as a Criterion for Demarcation

Karl Popper having criticized and rejected logical positivism expounded an entirely new system of demarcating science from other forms of intellectual enquiry. To be sure, Popper's notion of science is no doubt prescriptive in the sense that it portrays a method that scientific endeavours should follow. This method is falsification. Popper asserted that falsification would purify science from prejudice, speculation, assumptions and superstitions which are inherent features of non-science. So for Popper, for any hypothesis to assume a scientific status, it must be subjected to falsification. It is in the light of this that Popper presents falsification as a criterion for demarcating science from non-science. This way science has to aim at laws that are empirically testable and capable of surviving repeated attempts aimed at falsifying them. Corroborating this position, Antti Salovaara and Jani Merikwi opine that:

> The best theories are those that appear easy to falsify (e.g ones that provide surprising explanation or predictions) yet gain corroborating evidence, that is, survive repeated empirical attempts that seek to refute them. This definition was also Popper's answer to demarcation problem: theories should be falsifiable – formulated in a manner that provides a means for empirical examination that may lead to the theory's refutation. Unfalsifiable claims, in turn, would not be considered scientific.[21]

Popper's falsification simply entails that good theories make bold and empirically testable claims that have the capability of surviving repeated attempts of falsification. Thus, according to Karl Popper "scientific progress requires provisional falsifiable theories and their refutation that show where the existing theories need to be corrected".[22] Thus, Popper's demarcation criterion should not be seen in its own sake. Rather it should be seen not just as an endeavor that demarcates science from non-science but more as an endeavor that seeks to demonstrate the progressive character of science.

As it were, Popper's falsification opened a new vista towards understanding scientific progress. This is so because "scientific progress, following the falsificationist method, emerges from propositions of theories, their refutations, and replacement with corrected theories that better explain the phenomena of interest.[23] Therefore, falsification for Popper, is a fecund method in science in that

it aids the growth of knowledge as well as aids scientists improve on their theories by way of observing the theories that are lacking the scientific character. While commenting on Popper's falsification, Magee outlines its procedure this way:

> 1. Problem (usually rebuff to existing theory or expectation), 2. Proposed solution, in other words a new theory, 3. Deduction of testable propositions from the new theory, 4. tests, i.e attempted refutations by, among other things (but not only among other things), observations and experiment, 5. preference established between competing theories.[24]

In a similar fashion, Lee sums up the falsification style as follows: "consideration of predictions that would prove a theory being wrong, internal consistency of those predictions, corroboration and confirmation of the predictions with empirical data, and ruling out the rival theories".[25]

For Popper, falsification is an important criterion for distinguishing between science and non-science. Popper's contention is that verification does not have the requisite capability of producing a satisfactory criterion of demarcation. This is what exactly led Popper to posit that scientific theories should be distinguished from non-scientific theories by testable claims that future observations might portray to be false. In making his point more succinct, "Popper draws attention to the fact that scientific theories are characterized by the existence of potential counterfeiters – statement that might be found to be false".[26] This way, "Popper imagined that science progresses by successively rejecting falsified theories by keeping those with more explanatory power, rather than by falsified statements".[27]

In sum, Popper's falsification criterion demarcates science from non-science without imputing meaninglessness on metaphysics as with verificationism of logical positivists. Popper was actually influenced by Einstein's assertion that "in so far as statements of mathematics speak about reality, they are not certain, and in so far as they are certain, they do not speak about reality".[28] Popper reformulated the Einstein's assertion this way: "in so far as a scientific statement speaks about reality, it must be falsifiable, and in so far as it is not falsifiable, it does not speak about reality".[29] The reality in question here is referred to that which science seeks to explain out.

Thus, falsification is supposing that no scientific explanation about reality should be regarded as a finality. This is on account of reality in itself being subject to change. Here we may recall the position of Heraclitus that change is constant. May

it be explained here that Heraclitus made reference to the fact that realities are subject to change. If this is so, it therefore implies that scientific theories that seek to explain realities should as well be flexible so as to reflect the reality of realities. Therefore, Popper's falsification seeks to rule out unfalsifiable theories that seek to explain realities, from the encirclement of science.

Popper's Notion of Corroboration

The best way to present Popper's notion of corroboration is to explain it in terms of severe testing of theories. For Popper, theories that could not be falsified by sincere effort and attempt are to be tentatively corroborated. Because Popper differs with the members of Vienne circle in their verification principle, he pointed out that corroboration is significantly different from verification. Thus for Popper, corroborating a theory is different from verifying it and that after all, a theory cannot be verified whereas it can be corroborated. At this juncture, he dismissed the arguments of the verificationists who sought to input truthfulness, falsity and probability to statements. Popper's contention here is that it is worthless to lay claims about probability of hypothesis in science. Instead, Popper believes that interest in science should be focused on how far hypotheses have been able to withstand series of tests and trials. This in the language of Popper is the same thing as examining how far hypotheses have been corroborated.

Therefore, to say that a theory or hypothesis is corroborated is the same as saying that it has successfully passed through series of tests. Shedding light on this, Feigle posits that "Popper allows for corroboration in the sense that we may say that a theory which has withstood very severe tests is at least until further notice, acceptable as part of the justified corpus of scientific knowledge claims".[30] This goes to portray that the term corroboration in Popper's parlance can only be ascribed to a proposition tentatively and relatively and not actually absolutely. However, the qualities of universality and precision count in terms of degree of corroboration. That is to say that Popper holds that a theory has a high degree of corroboration if it has a high degree of universality. In the same vein, a theory that possesses the quality of precision has a better chance and degree of being corroborated as against imprecise theory. Therefore, for a test to be severely conducted upon a theory depends so much on the level of precision and universality of its assertion. Therefore, for Popper, the content and the nature of a scientific statement influences the extent of its testability and thus corroboration.

There is no doubt that Popper's effort within the terrain of Philosophy of science is to provide strong ground and foundation for scientific theories. Little wonder he postulates that real scientists are given to making bold conjectures. By bold conjectures, he means conjectures that can be severely and independently tested. These bold conjectures would later metamorphose into theories that are capable of standing a better chance of being corroborated as against those that cannot be corroborated. Popper found some examples of statements that cannot be corroborated in the prophecies or predictions of sooth-sayers. For him, they cannot be corroborated because of imprecision that characterize them. Concerning this claim, Popper substantiates that: "… we are inclined to doubt so much as their alleged logical improbability since we intend to believe that such prophecies are non-corroborable, we also tend to argue in such cases from their low degree of corroborability to their low degree of testability".[31] Popper's conception of corroboration denotes the geniuses of a scientific theory in terms of it withstanding severe tests. However, but more importantly, corroboration in Popper does not connote finality of scientific theory.

Conclusion

In the field of Philosophy of Science, there has not been any scholar that generated controversy by means of his theories as Karl Popper has done. In Popper's Philosophy of science, the two major issues of controversy are his attack on induction and his formulation of falsification as a method in science. Some philosophers of science see Popper's falsification as a failed project. For them, Popper's rejection of induction amounts to an unaccomplishable project. Their argument is that induction is the only veritable method in science and remains so. They contend that scientists in their undertakings and practice proceed by inductive method.

Induction, as it were, is the process of accumulation of evidences for purposes of making generalization and future references. That is to say that in induction, inferences have observations as premises and theories as conclusions. This simply implies that inductive method is the process of constructing a general law from observation of particular instances. This is the bone of contention for Popper when he argues that "for any conclusion drawn in this way may always turn out to be false; no matter how many instances of white swans we may have observed, does not justify the conclusion that all swans are white".[32] From the look of things, Popper's argument seems to have some merit in the sense that the so called generalization from induction does not really possess a conclusive claim.

However, some antagonists of Popper still argue that a scientist or a researcher does not need to examine all the samples of any object under his investigation before he draws a conclusion. This shows that they admitted the cumbersome and the impossible nature of the inductive process. May it be noted that it is as a result of the difficulty of inductive method in reaching a justifiable and valid theory in science that propelled Popper to posit that the real procedure of science is to operate from conjectures. That explains why he asserts that "all human knowledge is fallible and conjectural … a product of the method of trial and error".[33] By this, Popper means that scientists bring forth bold conjectures for trials and then carry out systematic falsification of those conjectures. The import of this in the Philosophy of Popper is that scientific hypotheses are not arrived at by induction but rather, are formed by creative imagination. This is interesting in the sense that it takes us to the knowledge of the link or the nexus between science and metaphysics. Pointing this out, Watkins writing about Kant's belief in the metaphysical aspect of science states that "according to Kantian presupposition, there are certain metaphysical assumptions which must remain under the shelter of the umbrella of science so long as science exists".[34]

It should be pointed out at this juncture that the nexus between science and metaphysics can only be possible by means of the conjectural aspect of science as postulated by Popper and not by the conventionalist view of induction. In lauding Popper's stance, N.G. Diora stated that "one of the most important achievements of Popper's Epistemology was his defence of the possibility of talking about knowledge growth without necessity to adhere to foundationalist model, also important is his claim that we don't need either to think knowledge progress as accumulation".[35] For Diora therefore, accumulation of evidence to justify scientific theories occasions inductivism which does not help in the progress of science. This implies that Diora aligns with Popper who holds that we cannot achieve truth by means of induction. Besides, Popper's aim in his Philosophy of Science is to ensure progress in science. For him, progress in science is from problems to solutions. Thus science starts from problems and not observations and therefore, not from induction.

References

1. K.R. Popper, *The Logic of Scientific Discovery,* (London: Routledge, 1959), p.27.

2. D. Hume, *Enquiry Concerning Human Understanding,* quoted in Popper, *Conjectures and Refutations: The Growth of scientific knowledge,*(London: Routledge and Kegan Paul, 1963), p.42.
3. Ibid.
4. K.R. Popper, *Conjectures and Refutations: The Growth of Scientific* knowledge, (London: Routledge and Kegan Paul, 1963), p.42.
5. K.R. *Popper, Objective Knowledge: An Evolutionary Approach,* (London: Oxford University Press, 1972), p. 4.
6. N. Sfetcu, "The distinction between falsification and refutation in the demarcation problem of Karl Popper; https://www.telework.ro/e-books/the-distinction-between-falsification-and-refutation-in-the-demarcation-problem-of-karl-popper/p.9.
7. S. Thornton, "Karl Popper", in *The Stanford Encyclopedia of Philosophy,* (ed.) Edward N. Zalta, (Stanford: Metaphysics Research Lab, Stanford University, 2017), p. 11. https://plato.stanford.edu/archieves/sum2017/entries/popper/. p.17.
8. K. Popper, *Conjectures and Refutations: The Growth of Scientific knowledge,* (Hove; Psychology Press, 2002), p.17.
9. N. Sfetcu, pp.9-10.
10. Ibid., p.10
11. S. Thornton, p.19.
12. A.C. Grayling, *Wittgenstem: A very short Introduction,* OUP Oxford, 2001, quoted in N. Sfetcu, op. cit, p.6.
13. S.O. Hansson, "Science and Pseudo-Science", in *The Standard Encyclopedia of Philosophy* (ed.) Edward N. Zalta, (Stanford: Metaphysics Research Lab, Stanford University, 2017), quoted in N. Sfetcu, op. cit, p.6.
14. D. Miller, *Popper Selections*, (New Jersey: Princeton University Press, 1985), quoted in N. Sfetcu, op.cit, p. 6.
15. K.R. Popper, *Conjectures and Refutations,* (Hove: Psychology Press, 2003), quoted in N. Sefcu, op. cit, pp.6-7.
16. N. Sfetcu, Op.cit, p.7
17. Ibid., p.8
18. Ibid.
19. Ibid, pp. 8-9.
20. K.R. Popper, *The Logic of Scientific Discovery* (Hove: Psychology Press, 2002), quoted in N. Sefcu, op. cit, p.9.

21. A. Salovaara & J. Merikivi, "IS Research Progress would benefit from increased falsification of Existing theories", Twenty-Third Conference on Information Systems (ECIS), Munster, Germany, 2015), p.3.
22. Ibid., p.1.
23. Ibid., p.3.
24. B. Magee, *Popper,* (London: Fontana Press, 1973), p.56.
25. A.S. Lee, "A Scientific Methodology for MIS Case Studies", *MIS Quarterly,*13, (1989), p.36.
26. N. Sfetcu, op.cit., p.13.
27. Ibid.p.14.
28. K.R. Popper, *The Logic of Scientific Discovery* (London: Routledge, 1989), p.314.
29. Ibid.
30. H. Feigle, "What Hume Might Have said to Kant" in M. Bunge (ed.), *The Critical Approach to Science and Philosophy in Honour of Karl Popper,* (London: The Free Press of Glencoe, 1964), p.48.
31. K.R. Popper, *The Logic of Scientific Discovery*, p.270.
32. K.R Popper, *The Logic of Scientific Discovery,* (London: Routledge, 1959), p. 27.
33. K.P. Popper, *Conjectures and Refutations: The Growth of Scientific Knowledge* 2nd edition, (New York: Basic books, 1965). p. 116.
34. J.W.N, Watkins, "Metaphysics and the Advancement of Science" in the *British Journal for the Philosophy of Science,* 26, (1975), p. 91.
35. N.D. Diora, "No More than Conjectures: Popper and the Ethics of Scientific Enterprise", *Integrative Psychological and Behavioural Science*, 43 (2009). p.122.
36. Kanu, Ikechukwu A., "Igwebuike philosophy of science and technology". *Nnadiebube Journal of Education. Vol. 5. No. 4, pp. 64-74, 2020;* Kanu, Ikechukwu A., "Igwebuike and the Question of Superiority in the Scientific Community of Knowledge". *Journal of African Studies and Sustainable Development*. Vol. 1. No. 1. pp. 131-138, 2018; Kanu, Ikechukwu A., "Genetic Engineering and the Quest for a Perfect Society: Religion and Science in Dialogue". *AMAMIHE: Journal of Applied Philosophy*. Vol. 10. No. 1. pp. 63-70, 2012.