HOW THE SCIENTIST THINKS

1. Scientific thinking is not something quite different from ordinary thinking.

2. It is reflective thinking at its best: careful, methodical, and systematic

3. It will be useful when we are confronted with difficult problems.

4. Symptoms don't just happen by themselves.

5. Scientific thinking begins with a problem.

6. Finding the cause of symptoms

7. When our thinking is directed towards a definite goal, when we have a problem which requires solution, we think hard.

8. When we engage in day dreaming, reverie or random thinking, our thinking lacks such direction.

9. A scientific problems should be formulated in a precise manner. It should be "localised" and admit of a definite answer.

10. Inquiry initiated by: disturbing situation which generated the inquiry, precise formulation of the problem

11. Next, observation of the facts; those that are relevant to that have a bearing on the problem.

12. Scientist brings a fund of previous knowledge.

13. Knowledge tells him that he should look for the answers in certain directions and not in others.

14. His knowledge furnishes him with a set of "preliminary hypothesis" or suggestions towards the solution of the problem.

15. These give him a set of alternative possible solutions.

16. May not be clearly formulated in the conscious mind, but they are there.

17. When scientist collects facts or data, he knows what type of facts are relevant to his problem and what types he may disregard as irrelevant.

18. An untrained individual cannot diagnose a disease, because he doesn't know what symptoms to look for, and how to interpret what he sees. Previous knowledge gives the scientist "ideas" provisionally accepted assumptions as to what <u>may</u> be the solution of the problem.

19. Trained observer sees more than the untrained Scientist:

- Doesn't just "look" at facts
- Nor is a mere fact collector
- Does not go aimlessly picking up scattered information
- Seeks facts relevent to a particular problem
- All observations centre around his problem
- Working hypothesis tell him what to look for

20. Charles Darwin: "No one can be a good observer unless he is a good theorizer"

21. How odd it is that anyone should not see that all observation must be for or against some view, if it is to be of any service.]

22. Observation, then is necessarily selective, but it should not be subjective.

23. Scientist, must guard himself against the kind of bias that makes him see only what he wants to see, even though it is not there. Or to ignore what is there because it is inconsistent with the theory he wishes to verify.

24. Science is self corrective. Every scientific statement is open to constant questioning.

25. Explanatory hypothesis or theory An explanatory hypothesis is the formulation of a suggested solution of the problem

26. Two kinds of hypothesis:

A) Preliminary provisional guesses which tell us what to look for in the beginning of an investigation

B) Major explanatory hypothesis or theory which is put forth as a solution of the problem

27. A good explanatory hypothesis should have two main characteristics: It must fit all known facts; It must be capable of being tested.

28. A great explanatory hypothesis involves the ability to see new connections, and new abstract relationships.

29. Thoroughness of research may often be a satisfactory substitute for imagination, as in industrial research but in higher levels of science it is never a complete substitute.

30. Previous knowledge : Of great importance for genius and non-genius alike. Can give us our explanatory hypothesis, when we suddenly see the connection between observed fact and a known principle.

31. An adequate explanatory hypothesis must also be capable of being tested – a scientific hypothesis

32. Indispensable if we are to have reliable and verifiable knowledge.

33. An explanatory hypothesis must capable of being tested and it must also be tested.

34. A hypothesis may fit known facts, but other hypothesis may fit the known facts equally well.

35. A list is required to determine which of them is true.

36. When two confirmed hypothesis are capable of explaining known facts very well, then, the scientist will generally prefer the simpler one.

37. Eight distinct steps in scientific method :

i) The situation which generates the enquiry.
ii) The precise formulation of the problem.
iii) Observation of the relevant facts.
iv) The use of previous knowledge.
v) The formulation of the explanatory hypothesis
vi) Deductions from the hypothesis ; if the hypothesis is true, certain consequences can be predicted. The working out of the implications of the hypothesis tells us what facts will verify or confirm the hypothesis.
vii) Testing the hypothesis by further observation or experiment.
viii) Conclusion: the hypothesis is confirmed or not confirmed. At eight the problem of diagnosis is solved.

38. Science combines rational and empirical procedures. Without reasoning there is no developed science.

39. Observed fact and a known principle Theory has its purpose ; Of great importance for genius and non-genius alike.

40. Can give us our explanatory hypothesis, when we suddenly see the connection between

41. Leads to the discovery and understanding the facts.

42. An explanatory hypothesis must be in accord with the known facts and if predicted facts do not turn up as expected, the theory must be discarded.

43. Science is loyal not to persons or institutions but to the process of attaining truth.

44. Scientist: Tells us what he has tested; Whether tests have confirmed or disproved hypothesis ; claims probability for conclusions.

Extracts from : The Art of Making sense – A Guide to Logical Thinking
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