ABBOT, F. E. THE SCIENTIFIC METHOD. pdf

1: Francis Ellingwood Abbot - Wikipedia

Francis Ellingwood Abbot (November 6, - October 23,) was an American philosopher and theologian who sought to reconstruct theology in accord with scientific method.

Timeline of the history of scientific method Aristotle , â€" BCE. A polymath, considered by some to be the father of modern scientific methodology , due to his emphasis on experimental data and reproducibility of its results. This is the greatest piece of Retroductive reasoning ever performed. According to Albert Einstein , "All knowledge of reality starts from experience and ends in it. Propositions arrived at by purely logical means are completely empty as regards reality. Because Galileo saw this, and particularly because he drummed it into the scientific world, he is the father of modern physics â€" indeed, of modern science altogether. The term "scientific method" did not come into wide use until the 19th century, when other modern scientific terminologies began to emerge such as "scientist" and "pseudoscience" and significant transformation of science was taking place. The scientific method is the process by which science is carried out. This is in opposition to stringent forms of rationalism: A strong formulation of the scientific method is not always aligned with a form of empiricism in which the empirical data is put forward in the form of experience or other abstracted forms of knowledge; in current scientific practice, however, the use of scientific modelling and reliance on abstract typologies and theories is normally accepted. The scientific method is of necessity also an expression of an opposition to claims that e. Different early expressions of empiricism and the scientific method can be found throughout history, for instance with the ancient Stoics , Epicurus , [29] Alhazen , [30] Roger Bacon , and William of Ockham. From the 16th century onwards, experiments were advocated by Francis Bacon , and performed by Giambattista della Porta , [31] Johannes Kepler , [32] and Galileo Galilei. The hypothetico-deductive model [35] formulated in the 20th century, is the ideal although it has undergone significant revision since first proposed for a more formal discussion, see below. Staddon argues it is a mistake to try following rules [36] which are best learned through careful study of examples of scientific investigation. Process The overall process involves making conjectures hypotheses , deriving predictions from them as logical consequences, and then carrying out experiments based on those predictions to determine whether the original conjecture was correct. Though the scientific method is often presented as a fixed sequence of steps, these actions are better considered as general principles. As noted by scientist and philosopher William Whewell â€" , "invention, sagacity, [and] genius" [11] are required at every step. Formulation of a question The question can refer to the explanation of a specific observation , as in "Why is the sky blue? If the answer is already known, a different question that builds on the evidence can be posed. When applying the scientific method to research, determining a good question can be very difficult and it will affect the outcome of the investigation. A statistical hypothesis is a conjecture about a given statistical population. For example, the population might be people with a particular disease. The conjecture might be that a new drug will cure the disease in some of those people. Terms commonly associated with statistical hypotheses are null hypothesis and alternative hypothesis. A null hypothesis is the conjecture that the statistical hypothesis is false; for example, that the new drug does nothing and that any cure is caused by chance. Researchers normally want to show that the null hypothesis is false. The alternative hypothesis is the desired outcome, that the drug does better than chance. Prediction This step involves determining the logical consequences of the hypothesis. One or more predictions are then selected for further testing. The more unlikely that a prediction would be correct simply by coincidence, then the more convincing it would be if the prediction were fulfilled; evidence is also stronger if the answer to the prediction is not already known, due to the effects of hindsight bias see also postdiction. Ideally, the prediction must also distinguish the hypothesis from likely alternatives; if two hypotheses make the same prediction, observing the prediction to be correct is not evidence for either one over the other. Scientists and other people test hypotheses by conducting experiments. The purpose of an experiment is to determine whether observations of the real world agree with or conflict with the predictions derived from a hypothesis. If they agree, confidence in the hypothesis increases; otherwise, it decreases. Agreement does not assure that the hypothesis is true; future experiments may reveal problems. Karl Popper advised scientists to try to falsify hypotheses, i. Large numbers of successful confirmations are not convincing if they arise from experiments that avoid risk. For example, tests of medical treatments are commonly run as double-blind tests. Test personnel, who might unwittingly reveal to test subjects which samples are the desired test drugs and which are placebos , are kept ignorant of which are which. Such hints can bias the responses of the test subjects. Furthermore, failure of an experiment does not necessarily mean the hypothesis is false. Experiments always depend on several hypotheses, e. See the Duhemâ€"Quine thesis. Astronomers do experiments, searching for planets around distant stars. Finally, most individual experiments address highly specific topics for reasons of practicality. As a result, evidence about broader topics is usually accumulated gradually. Analysis This involves determining what the results of the experiment show and deciding on the next actions to take. The predictions of the hypothesis are compared to those of the null hypothesis, to determine which is better able to explain the data. In cases where an experiment is repeated many times, a statistical analysis such as a chi-squared test may be required. If the evidence has falsified the hypothesis, a new hypothesis is required; if the experiment supports the hypothesis but the evidence is not strong enough for high confidence, other predictions from the hypothesis must be tested. Once a hypothesis is strongly supported by evidence, a new question can be asked to provide further insight on the same topic. Evidence from other scientists and experience are frequently incorporated at any stage in the process. Depending on the complexity of the experiment, many iterations may be required to gather sufficient evidence to answer a question with confidence, or to build up many answers to highly specific questions in order to answer a single broader question. DNA example The basic elements of the scientific method are illustrated by the following example from the discovery of the structure of DNA: Previous investigation of DNA had determined its chemical composition the four nucleotides , the structure of each individual nucleotide, and other properties. It had been identified as the carrier of genetic information by the Averyâ€"MacLeodâ€"McCarty experiment in , [40] but the mechanism of how genetic information was stored in DNA was unclear. Watson hypothesized that DNA had a helical structure. This prediction was a mathematical construct, completely independent from the biological problem at hand. The results showed an X-shape. When Watson saw the detailed diffraction pattern, he immediately recognized it as a helix. Each step of the example is examined in more detail later in the article. Other components The scientific method also includes other components required even when all the iterations of the steps above have been completed: As a result, it is common for a single experiment to be performed multiple times, especially when there are uncontrolled variables or other indications of experimental error. For significant or surprising results, other scientists may also attempt to replicate the results for themselves, especially if those results would be important to their own work. Some journals request that the experimenter provide lists of possible peer reviewers, especially if the field is highly specialized. Peer review does not certify correctness of the results, only that, in the opinion of the reviewer, the experiments themselves were sound based on the description supplied by the experimenter. If the work passes peer review, which occasionally may require new experiments requested by the reviewers, it will be published in a peer-reviewed scientific journal. The specific journal that publishes the results indicates the perceived quality of the work. This allows scientists to gain a better understanding of the topic under study, and later to use that understanding to intervene in its causal mechanisms such as to cure disease. The better an explanation is at making predictions, the more useful it frequently can be, and the more likely it will continue to explain a body of evidence better than its alternatives. The most successful explanations â€" those which explain and make accurate predictions in a wide range of circumstances â€" are often called scientific theories. Most experimental results do not produce large changes in human understanding; improvements in theoretical scientific understanding typically result from a gradual process of development over time, sometimes across different domains of science. In general, explanations become accepted over time as evidence accumulates on a given topic, and the explanation in question proves more powerful than its alternatives at explaining the evidence. Often subsequent researchers re-formulate the explanations over time, or combined explanations to produce new explanations. Tow sees the scientific method in terms of an evolutionary algorithm applied to science and technology. That is, no theory can ever be considered final, since new problematic evidence might be discovered. If such evidence is found, a new theory may be proposed, or more commonly it is found that modifications to the previous theory are sufficient to explain the new evidence. The strength of a theory can be argued[by whom? Theories can also become subsumed by other theories. Thus, in certain cases independent, unconnected, scientific observations can be connected to each other, unified by principles of increasing explanatory power. In subsequent modifications, it has also subsumed aspects of many other fields such as biochemistry and molecular biology. This demonstrates a use of photography as an experimental tool in science. Scientific methodology often directs that hypotheses be tested in controlled conditions wherever possible. This is frequently possible in certain areas, such as in the biological sciences, and more difficult in other areas, such as in astronomy. The practice of experimental control and reproducibility can have the effect of diminishing the potentially harmful effects of circumstance, and to a degree, personal bias. For example, pre-existing beliefs can alter the interpretation of results, as in confirmation bias ; this is a heuristic that leads a person with a particular belief to see things as reinforcing their belief, even if another observer might disagree in other words, people tend to observe what they expect to observe. Such proto-ideas are at first always too broad and insufficiently specialized. Once a structurally complete and closed system of opinions consisting of many details and relations has been formed, it offers enduring resistance to anything that contradicts it. MacKay has analyzed these elements in terms of limits to the accuracy of measurement and has related them to instrumental elements in a category of measurement. The scientific community and philosophers of science generally agree on the following classification of method components. These methodological elements and organization of procedures tend to be more characteristic of natural sciences than social sciences. Nonetheless, the cycle of formulating hypotheses, testing and analyzing the results, and formulating new hypotheses, will resemble the cycle described below. The scientific method is an iterative, cyclical process through which information is continually revised. These activities do not describe all that scientists do see below but apply mostly to experimental sciences e. The elements above are often taught in the educational system as "the scientific method". A linearized, pragmatic scheme of the four points above is sometimes offered as a guideline for proceeding: Characterizations The scientific method depends upon increasingly sophisticated characterizations of the subjects of investigation. The subjects can also be called unsolved problems or the unknowns.

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2: Steps of the Scientific Method

TO BOTTOM OF PAGE Introduction to Scientific Theism by Francis Ellingwood Abbot [In addition to being the introduction to the book Scientific Theism, this paper apparently appeared first in the London Mind for October, , where it appeared with the title, "Scientific Philosophy: A Theory of Human Knowledge."].

Most training programs for Six Sigma seem to focus on teaching the tools rather than driving home the importance of scientific problem-solving for process improvement. That is where breakthroughs really begin. A Six Sigma project team aims to solve a problem through identification of the true root cause and application of a solution that reduces the impact of the root cause. Most literature available on Six Sigma today fails to emphasize this turning point. That is, relate all the key inputs to each expected output within a small magnitude of error Figure 2. In the Define phase, the process is described qualitatively in relation to the business, using tools such as a SIPOC diagram. Expectations from the process are specified quantitatively through capture of the voice of the customer. The key outputs Y and critical-to-satisfaction elements are revealed. A detailed process map focused on the key outputs will provide a list of inputs. The Define phase identifies the key outputs and all the known inputs. In the Measure phase, the list of x and Y variables are measured, including all possible error E components. This is where Lean thinking really meets Six Sigma. A thorough value stream mapping exercise will reveal the waste or errors as well as sources of variation in the process. Now the problem is in a form that lends itself to statistical analysis Figure 4. Type I and Type II Errors After analyzing the error components, if a significant amount of information is missing residual error then the Define and Measure phases must be revisited. That is, if Ha cannot be rejected then Ho must be re-formed. If Ha can be rejected, then the process-inherent error components are ready for further analysis in preparation for the Improve phase. To improve the process, concentrate all efforts on relating the sources of variation to the identified waste imbedded in the process. A process map and information gathered during the Measure phase are helpful at this stage. Breakthrough improvement happens when the project team is able to bring the net E to zero and can simulate the output based on the inputs. How accurately the output is predicted is one measure of Six Sigma success. Once the Improve phase has established how to predict the Y, the Control phase begins. This is accomplished by performing DOE to validate the relationship. Understanding the impact of risks through completion of a failure modes and effects analysis of the improved state also is key. The final step is to assimilate the knowledge gained through the improvement process into the current system by implementing any necessary changes in procedure or statistical process control charts. A bottom-up or rapid improvement using Six Sigma will often deploy Lean principles to perfect the process by removing all waste error components. The Six Sigma methodology is successful as long as the organization learns to solve problems using the scientific method.

3: General Format for Writing a Scientific Paper

Introduction to f e abbot's scientific theism, francis ellingwood abbot [in addition to being the introduction to the book scientific theism, this paper apparently appeared first in the london mind for october, , where it appeared with the title, "scientific.

The order of the works is not chronological the chronology is now difficult to determine but was deliberately chosen by Theophrastus to constitute a well-structured system. Aristotle discusses the square of opposition or square of Apuleius in Chapter 7 and its appendix Chapter 8. Chapter 9 deals with the problem of future contingents. The Prior Analytics Greek: The Posterior Analytics Greek: Analytica Posteriora deals with demonstration , definition , and scientific knowledge. Topica treats of issues in constructing valid arguments, and of inference that is probable, rather than certain. It is in this treatise that Aristotle mentions the predicables , later discussed by Porphyry and by the scholastic logicians. The Sophistical Refutations Greek: Aristotle introduced what may be called a scientific method. He provided another of the ingredients of scientific tradition: For Aristotle, universal truths can be known from particular things via induction. To some extent then, Aristotle reconciles abstract thought with observation, although it would be a mistake to imply that Aristotelian science is empirical in form. Indeed, Aristotle did not accept that knowledge acquired by induction could rightly be counted as scientific knowledge. Nevertheless, induction was for him a necessary preliminary to the main business of scientific enquiry, providing the primary premises required for scientific demonstrations. Aristotle largely ignored inductive reasoning in his treatment of scientific enquiry. To make it clear why this is so, consider this statement in the Posterior Analytics: We suppose ourselves to possess unqualified scientific knowledge of a thing, as opposed to knowing it in the accidental way in which the sophist knows, when we think that we know the cause on which the fact depends, as the cause of that fact and of no other, and, further, that the fact could not be other than it is. It was therefore the work of the philosopher to demonstrate universal truths and to discover their causes. For this task Aristotle used the tool of deductive reasoning in the form of syllogisms. Using the syllogism, scientists could infer new universal truths from those already established. Aristotle developed a complete normative approach to scientific inquiry involving the syllogism, which he discusses at length in his Posterior Analytics. A difficulty with this scheme lay in showing that derived truths have solid primary premises. Aristotle would not allow that demonstrations could be circular supporting the conclusion by the premises, and the premises by the conclusion. Nor would he allow an infinite number of middle terms between the primary premises and the conclusion. This leads to the question of how the primary premises are found or developed, and as mentioned above, Aristotle allowed that induction would be required for this task. Towards the end of the Posterior Analytics, Aristotle discusses knowledge imparted by induction. Thus it is clear that we must get to know the primary premises by induction; for the method by which even sense-perception implants the universal is inductive. In particular, it seems that Aristotle considers sense-perception only as a vehicle for knowledge through intuition. He restricted his investigations in natural history to their natural settings, [18] such as at the Pyrrha lagoon, [19] now called Kalloni , at Lesbos. Aristotle and Theophrastus together formulated the new science of biology, [20] inductively, case by case, for two years before Aristotle was called to tutor Alexander. With that said, Aristotle brings us somewhat closer an empirical science than his predecessors. Some philosophers held that there are only atoms and void ; others that the atoms are divine fire , others only wind , others only water , others only earth. Emergence of inductive experimental method[edit] During the Middle Ages issues of what is now termed science began to be addressed. There was greater emphasis on combining theory with practice in the Islamic world than there had been in Classical times, and it was common for those studying the sciences to be artisans as well, something that had been "considered an aberration in the ancient world. Several scientific methods thus emerged from the medieval Muslim world by the early 11th century, all of which emphasized experimentation as well as quantification to varying degrees. Ibn al-Haytham[edit] "How does light travel through transparent bodies? Light travels through transparent bodies in straight lines only We have explained this exhaustively in our Book of Optics. He combined observations , experiments and rational arguments to support his intromission theory of vision , in which rays of light are emitted from objects rather than from the eyes. He used similar arguments to show that the ancient emission theory of vision supported by Ptolemy and Euclid in which the eyes emit the rays of light used for seeing , and the ancient intromission theory supported by Aristotle where objects emit physical particles to the eyes , were both wrong. And those who are engaged upon the quest for anything for its own sake are not interested in other things. Finding the truth is difficult, and the road to it is rough. He stated, "[This] is clearly observed in the lights which enter into dark rooms through holes. He also explained the role of induction in syllogism , and criticized Aristotle for his lack of contribution to the method of induction, which Ibn al-Haytham regarded as superior to syllogism, and he considered induction to be the basic requirement for true scientific research. For example, after demonstrating that light is generated by luminous objects and emitted or reflected into the eyes, he states that therefore "the extramission of [visual] rays is superfluous and useless. He wrote that "we do not go beyond experience, and we cannot be content to use pure concepts in investigating natural phenomena", and that the understanding of these cannot be acquired without mathematics. After assuming that light is a material substance, he does not further discuss its nature but confines his investigations to the diffusion and propagation of light. The only properties of light he takes into account are those treatable by geometry and verifiable by experiment. For example, in his treatise on mineralogy , Kitab al-Jawahir Book of Precious Stones , al-Biruni is "the most exact of experimental scientists", while in the introduction to his study of India , he declares that "to execute our project, it has not been possible to follow the geometric method" and thus became one of the pioneers of comparative sociology in insisting on field experience and information. Biruni was concerned with how to conceptualize and prevent both systematic errors and observational biases, such as "errors caused by the use of small instruments and errors made by human observers. Avicenna discussed the issue of a proper procedure for scientific inquiry and the question of "How does one acquire the first principles of a science? Avicenna criticized Aristotelian induction, arguing that "it does not lead to the absolute, universal, and certain premises that it purports to provide. Concluding from particular observations into a universal law, and then back again, from universal laws to prediction of particulars. Grosseteste called this "resolution and composition". Further, Grosseteste said that both paths should be verified through experimentation to verify the principles. In his account of a method, Bacon described a repeating cycle of observation , hypothesis , experimentation , and the need for independent verification. About he joined the Franciscan Order and became subject to the Franciscan statute forbidding Friars from publishing books or pamphlets without specific approval. After the accession of Pope Clement IV in , the Pope granted Bacon a special commission to write to him on scientific matters. There are two methods of knowledge: Mere argument is never sufficient; it may decide a question, but gives no satisfaction or certainty to the mind, which can only be convinced by immediate inspection or intuition, which is what experience gives. Experimental science, which in the Opus Tertium p. It verifies their conclusions by direct experiment; It discovers truths which they could never reach; It investigates the secrets of nature, and opens to us a knowledge of past and future. Roger Bacon illustrated his method by an investigation into the nature and cause of the rainbow , as a specimen of inductive research. Within the sciences, medieval philosophers were not afraid of disagreeing with Aristotle on many specific issues, although their disagreements were stated within the language of Aristotelian philosophy. All medieval natural philosophers were Aristotelians, but "Aristotelianism" had become a somewhat broad and flexible concept. With the end of Middle Ages, the Renaissance rejection of medieval traditions coupled with an extreme reverence for classical sources led to a recovery of other ancient philosophical traditions, especially the teachings of Plato. Basle The discovery of the Americas at the close of the 15th century showed the scholars of Europe that new discoveries could be found outside of the authoritative works of Aristotle, Pliny, Galen, and other ancient writers. Galen of Pergamon â€” c. In his Methodus Medendi, Galen had synthesized the empirical and dogmatic schools of medicine into his own method, which was preserved by Arab scholars. Thomas Linacre , the teacher of Erasmus, thereupon translated Methodus Medendi from Greek into Latin for a larger audience in As a physician, Leoniceno was concerned about these botanical errors propagating to the materia medica on which medicines were based. Other Renaissance teaching gardens were established, notably by the physician Leonhart Fuchs , one of the founders of botany. Skepticism either denies or strongly doubts depending on the school the possibility of certain knowledge. In this, he is echoed by Francis Bacon who was influenced by another prominent exponent of skepticism, Montaigne ; Sanches cites the humanist Juan Luis Vives who sought a better educational system, as well as a statement of human rights as a pathway for improvement of the lot of the poor. In the meantime, as I prepare to examine Things, I shall raise the question anything is known, and if so, how, in the introductory passages of another book, [58] a book in which I will expound, as far as human frailty allows, [59] the method of knowing. Baconian method "If a man will begin with certainties, he shall end in doubts; but if he will be content to begin with doubts, he shall end in certainties. He believed philosophy must be taught its true purpose, and for this purpose a new method must be devised. With this conception in his mind, Bacon left the university. As Bacon put it, [A]nother form of induction must be devised than has hitherto been employed, and it must be used for proving and discovering not first principles as they are called only, but also the lesser axioms, and the middle, and indeed all. For the induction which proceeds by simple enumeration is childish. In an example he gives on the examination of the nature of heat, Bacon creates two tables, the first of which he names "Table of Essence and Presence", enumerating the many various circumstances under which we find heat. In the other table, labelled "Table of Deviation, or of Absence in Proximity", he lists circumstances which bear resemblance to those of the first table except for the absence of heat. From an analysis of what he calls the natures light emitting, heavy, colored, etc. Those natures which are always present in the first table, but never in the second are deemed to be the cause of heat. The role experimentation played in this process was twofold. Such histories would document a mixture of common knowledge and experimental results. Secondly, experiments of light, or, as we might say, crucial experiments would be needed to resolve any remaining ambiguities over causes. Bacon showed an uncompromising commitment to experimentation. Despite this, he did not make any great scientific discoveries during his lifetime. This may be because he was not the most able experimenter. Bacon gave a substantial but secondary role to mathematics "which ought only to give definiteness to natural philosophy, not to generate or give it birth" Novum Organum XCVI. There are and can be only two ways of searching into and discovering truth. The one flies from the senses and particulars to the most general axioms, and from these principles, the truth of which it takes for settled and immoveable, proceeds to judgment and to the discovery of middle axioms. And this way is now in fashion. The other derives axioms from the senses and particulars, rising by a gradual and unbroken ascent, so that it arrives at the most general axioms last of all. This is the true way, but as yet untried. Lastly, we have three that raise the former discoveries by experiments into greater observations, axioms, and aphorisms. These we call interpreters of nature.

4: Scientific Method | Definition of Scientific Method by Merriam-Webster

organic scientific philosophy scientific theism by francis ellingwood abbot, ph.d. boston little, brown, and company

By adhering to this format, researchers maintain a consistent and efficient means of communicating with the scientific community. This order is really quite logical and could apply to almost any report you might write. You can benefit from writing good scientific papers, even if you do not expect to go on in Biology. Preparing a scientific paper develops your ability to organize ideas logically, think clearly, and express yourself accurately and concisely. Mastery of these skills would be an asset for any career that you may pursue. All papers should be typed, double-spaced except the abstract , with at least one-inch margins on all sides. Title Page The title page is the first page of the paper and should contain the following: The following titles would be uninformative and too general: The Abstract states clearly and concisely what is dealt with in the paper. It is a concise statement of the questions, general procedure, basic findings, and main conclusions of the paper. This is a brief, all encompassing section summarizing what you discuss in the rest of the paper, and should be written last, after you know what you have said! Introduction The Introduction presents a background for the work you are doing and put it into an appropriate context e. What questions are you asking in your study? What organisms or ideas were studied and why are they interesting or relevant? Identify the subject s and hypotheses of your work. Tell the reader why s he should keep reading and why what you are about to present is interesting. Briefly state your general approach or methods e. Cite any references you used as sources for your background Information. This section should be written in the past tense when referring to this experiment. Previously published work is considered part of the present body of knowledge. Do not keep the reader in suspense. Let the reader follow the development of the evidence. There should be enough detail that a competent worker can repeat the experiments. What procedures were followed? Are the treatments and controls clearly described? Does this section describe the sampling regime and sample sizes, including how individuals were assigned to treatments? What research materials were used: Briefly explain the relevance of the methods to the questions you introduced above e. If applicable, include a description of the statistical methods you used in your analysis. Careful writing of this section is important because the cornerstone of the scientific method requires that your results are reproducible, and for the results to be reproducible, you must provide the basis for the repetition of your experiments by others. This section should be written in the past tense. Your data should b presented succinctly in the body of the report and presented in detail as tables or graphs. However, do not present the same data in both tabular and graphical form in the same paper. Strive for clarity, the results should be short and sweet. The results section should be written so that any college student could read the text to learn what you have done. When the enzyme as soaked in sulfuric acid, it produced no change in absorbance When stating your results in the body of the text, refer to your graphs and tables. Tables and graphs alone do not make a Results section. In the text of this section describe your results do not list actual numbers, but point out trends or important features. Refer to the figures and tables by number as well as any other relevant information. Results are typically not discussed much more in this section unless brief discussion aids clarity. This is the place to tell the reader what you found out, not what it means. Each table and figure should be numbered sequentially for easy reference in the text of the Results and Discussion sections. Be sure to label both axes of all graphs e. Tables are numbered separately from the figures as Table 1 to Table X. Label columns, including units of measure, and define all treatments. Your reader should NEVER have to go back to the text to interpret the table or figure-- thus you need to provide a legend for each figure and a caption for each table. A figure legend is freestanding text that goes below the figure. The first sentence of the legend bold print in the example below is typically a succinct statement that summarizes what the entire figure is about. The first sentence is then followed with particulars of the figure contents, as appropriate, including information about methods, how the data are expressed, or any abbreviations etc. An example of a legend Light Micrograph of a Human Karyotype. Fetal cells were obtained from Aimee Biophiliac in September by amniocentesis. The cells were cultured, metaphase chromosome spreads were prepared and the chromosomes stained and photographed as described in Materials and Methods. Individual chromosomes were cut out from the photograph and arranged in a karyotype. By virtue of the presence of two X-chromosomes, the karyotype indicates that the developing fetus is a female. Based on other information data not presented , the fetus is expected to emerge March 19, A table caption is freestanding text located above the table. It presents a succinct statement of the contents of the table. A caption must NOT include information about methods, how the data are expressed, or any abbreviations if needed, those are included as footnotes to the table, with each footnote keyed to a footnote reference in the table by sequential, lettered superscripts. Discussion The discussion section is where you explain your results in detail, speculating on trends, possible causes, and conclusions. Try to present the principles, relationships, and generalizations shown by the Results. And bear in mind, in a good Discussion, you discuss--you do not recapitulate-- the Results. A good discussion section References or References Cited The References section is a complete list of all references that you cited within your paper. The references are listed in alphabetical order by last name of the first author of each publication. Include only those references that you have actually read and that you specifically mention in your paper. If a laboratory handout was used it is only a beginning and must be cited. When researching for information for the Introduction and Discussion sections or the paper, seek out original sources that are written by experts in the field e. Scientific American and books written by well respected scientists. Textbooks, although acceptable in this class as a last resort, are rarely cited in the scientific papers since information in textbooks is less reliable than from the original sources. In-Text Citations Citation formats are often discipline specific. Footnotes or endnotes are not normally used in scientific writing as they are in humanities and the social sciences. Because natural scientists most often use the Name-Year System, we will use this system in this course. All citations occur in the text in parentheses, with the author s and date of publication. Clinton found that naked foxes run on grass four times faster than those wearing pantyhose do. On grass surfaces, naked foxes run four times faster than those wearing pantyhose Clinton For example, Clinton et al. The complete list of authors will appear in the full citation at the end of your paper. The format of the References section varies slightly from one scientific journal to another. Use the following as examples for citing various kinds of sources in for this course Phenotypic design, plasticity and ecological performance in two tadpole species. Glimpsing the hidden majority. Activation of sea urchin eggs by a calcium ionophore. Epidemiology for primary health care.

5: Scientific Method Unit Test

Book digitized by Google from the library of the University of Michigan and uploaded to the Internet Archive by user tpb. Includes bibliographies Cope, E. D. Alfred Russel WallaceWakeman, T. B. Ernst HaeckelAbbot, F. E.

A Theory of Human Knowledge. It has hitherto been assumed that our cognition must conform to the objects; but all attempts to ascertain anything about these a priori, by means of conceptions, and thus to extend the range of our knowledge, have been rendered abortive by this assumption. Let us, then, make the experiment whether we may not be more successful in metaphysics, if we assume that the objects must conform to our cognition. We here propose to do just what Copernicus did in attempting to explain the celestial movements. When he found that he could make no progress by assuming that all the heavenly bodies revolved around the spectator, he reversed the process, and tried the experiment of assuming that the spectator revolved, while the stars remained at rest. We may make the same experiment with regard to the intuition of objects. If, on the other hand, the object conforms to the nature of our faculty of intuition, I can then easily conceive the possibility of such an a priori knowledge. This attempt to introduce a complete revolution in the procedure of metaphysics, after the example of the geometricians and natural philosophers, constitutes the aim of the Critique of Pure Speculative Reason. Lange, in his History of Materialism II. Kant himself was very far from comparing himself with Kepler; but he made another comparison that is more significant and appropriate. He compared his achievement with that of Copernicus. But this achievement consisted in this, that he reversed the previous standpoint of metaphysics. Copernicus dared, by a paradoxical but yet true method, to seek the observed motions, not in the heavenly bodies, but in their observers. It follows immediately from this that the objects of experience altogether are only our objects; that the whole objective world is, in a word, not absolute objectivity, but only objectivity for man and any similarly organized beings, while, behind the phenomenal world, the absolute nature of things, the thing-in-itself, is veiled in impenetrable darkness. The essence of Nominalism was the doctrine that universals, or terms denoting genera and species, correspond to nothing really existent outside of the mind, but are either mere empty names Extreme Nominalism or names denoting mere subjective concepts Moderate Nominalism or Conceptualism. Nominalism distinctly anticipated the Critical Philosophy in referring the source of all general conceptions and thereby of all human knowledge , not to the object alone or to the object and subject together, but to the subject alone; it distinctly anticipated the doctrine that "things conform to cognition, not cognition to things. Wrapped up in the essential doctrine of Nominalism, therefore, was the doctrine that things-in-themselves are utterly unknown; that the knowledge of their supposed resemblances and differences is derived only from the supposing mind; that "things conform to cognition, not cognition to things;" in short, that the only knowledge possible to man is the knowledge of the a priori constitution of his own mind, and the relations which it imposes upon things if they exist , totally irrespective of what things really are. Nothing can be plainer, then, than that the Critical Philosophy did but logically develop the prime tenet of Nominalism, formulate it successfully, and expand it to a self-consistent philosophical system. This, and this alone, was the true merit of Kant. The "revolution" by which philosophy was made to transfer its fundamental standpoint from the world of things to the world of thought, and in consequence of which modern philosophy in both its great schools has inherited an irresistible tendency towards Idealism, had been substantially effected and definitely established some four hundred years before. Kant did but bring to flower and fruitage the seed sown by Roscellinus, and his Critical Philosophy was only the logical evolution and outcome of Mediaeval Nominalism. In truth, all modern philosophy, by tacit agreement, rests upon the Nominalistic theory of universals. Hence alone can be explained the fact, so patent and so striking, yet so little understood or even inquired into, that both the great schools of modern philosophy, the Transcendental and the Associational, equally exhibit in its full force the tendency to Idealism latent in that theory. Nominalism logically reduces all experience, actual or possible, to a mere subjective affection of the individual Ego, and does not permit even the Ego to know itself as a noumenon. The historical development of the Critical Philosophy into the subjective idealism of Fichte, the objective idealism of Schelling, and the absolute idealism of Hegel, only shows how impossible it is for that philosophy to overstep the magic circle of Egoism with which Nominalism logically environed itself. It [Idealism] rests on generally recognized principles in regard to consciousness. Its definition of consciousness is the one most widely received: It maintains that the cognitions of consciousness are absolute and infallible, and that nothing but these is, in their degree, knowledge. In all these postulates the great mass of thinkers agree with Idealism. The foundation of Idealism is the common foundation of nearly all the developed philosophical thinking of all schools. Idealism declares that, while consciousness is infallible, our interpretations of it, on which we base inferences, may be incorrect; and nearly all thinkers of all schools agree with Idealism here. No inference, or class of inferences, in which a mistake ever occurs is a basis of positive knowledge. Therefore we know nothing more. So completely has this general conviction taken possession of the philosophical mind, that even antagonists of Idealism, who would cut it up by the roots if they could cut this up, have not pretended that it could be done. If all the general and special relations of things, conceived by the mind and expressed by general terms, exist in the mind alone, nothing is known of things themselves; for knowledge of things is knowledge of their relations. Nominalism, therefore, is the original source of the definition of knowledge adopted by Idealism, as shown above: Inasmuch, moreover, as the notion of a common consciousness is itself a general notion, and consequently destitute of all objectivity, nothing is "knowledge," so defined, that is outside of the individual consciousness. Beginning with Nominalism, therefore, Idealism must end in Solipsism, on penalty of stultifying itself by arbitrary self-contradiction. This was the path marked out for the Critical Philosophy by inexorable logic, and Fichte was more Kantian than Kant himself when he resolutely pursued it. Solipsism is the very reductio ad absurdum of Idealism, yet it is the rigorously logical consequence of its own definition of knowledge, which again is the rigorously logical consequence of the Nominalistic view of universals. On this point, a further quotation from Dr. Krauth will be extremely pertinent: While Idealism has here a speculative strength, which it is not wise to ignore, it is not without its weakness, even at this very point, for its history shows that it is rarely willing to stand unreservedly by the results they must of its own principle as regards consciousness. He cannot know that he has a substantial personal existence, or that there is any other being, finite or infinite, beside himself. Solipsism, or absolute Egoism, with the exclusion of proper personality, is the logic of Idealism, if the inferential be excluded. But if inference, in any degree whatever, be allowed, not only would the natural logic and natural inference of most men sweep away Idealism, but its own principle of knowledge is subverted by the terms of the supposition. Idealism stands or falls by the principle that no inference is knowledge. We may reach inferences by knowledge, but we can never reach knowledge by inference" p. Against both schools of modern philosophy, therefore, committed as they both are to the definition of knowledge drawn from Nominalism and ending in Solipsism, the charge of logical inconsistency and self-contradiction may be fairly brought, just so far as they hesitate to follow up the path to cloudland which begins with that definition. But any philosophy which hesitates to be logical forfeits all claim to the respectful consideration of mankind. Like the French Revolution, the Nominalistic revolution can live only by the guillotine, and decapitates every perception which pretends to bring to the miserable solipsist, shut up in the prison of his own consciousness, the slightest information as to the great outside world. Defining knowledge as the mere contents of consciousness, it relegates to non-entity, as pseudo-knowledge, whatever claims to be more than that. Under its sway, philosophy is blind to the race, and beholds the individual alone. What wonder that, in the hands of those who insist on their right to reduce theory to practice, philosophy is so often found pandering to the moral lawlessness of an Individualism that sets mere personal opinion above the supreme ethical sanctities of the universe? In human society, individual autonomy is universal antinomy; for the law that binds only one binds none. Yet, with Nominalism for its root, Idealism for its flower, and Solipsism for its fruit, how can modern philosophy, teaching in both its great schools that the individual mind knows nothing except the states of its own consciousness, discover any law that shall have recognized authority over all consciousnesses? For such a discovery it is hopelessly incompetent. So far, therefore, as the social and moral interests of mankind are concerned, the present philosophical situation has become simply intolerable. The protest of "common sense" against it was even taken up by the Scotch school in the name of philosophy itself; but the same Nominalism which paralyzes all modern philosophy paralyzed the Scotch school, and the protest died on its tongue. Without any conscious protest, however, though with an instinctive hostility to "metaphysics" and to the philosophy which it confounds with "metaphysics," physical science has immovably planted itself on a new definition of knowledge, and fortified it impregnably against all comers; and, on the principle of cognition which it establishes, universal science, carrying up the physical and the mental into the higher unity of the cosmical, is even now beginning to build a temple of truth destined to be coeval with the human race. Modern Philosophy defines knowledge as the recognition by the Ego of its own conscious states. The principle of cognition on which it proceeds is utterly antagonistic to the Nominalism which denies all objectivity to genera and species: Nominalism teaches that things conform to cognition, not cognition to things; Scientific Realism teaches that cognition conforms to things, not things to cognition. It is futile to seek a reconciliation of these positions; the contradiction is absolute and insoluble. Modern philosophy counts nothing as "known" which is outside of the individual consciousness; modern science presents as "known" a vast mass of truths, of which only an insignificant fraction can be to-day comprised within the narrow limits of a single consciousness, and which in their totality can be contained only in the universal mind of man. Under the influence of the all-prevailing Nominalism of the present day, philosophy has, and must have, its beginning-point in the individual Ego; under the influence of its own unsuspected Realism, science begins with a Cosmos of which the individual Ego is merely a part. The one is exclusively and narrowly subjective, just so far as it is logically faithful to its own clearly proclaimed principle of cognition; the other is objective, in a sense so broad as to include the subjective within itself. But let it not be forgotten that the old Realism of Scholasticism is by no means the new Realism of Science; the former perished as rightfully before Nominalism as Nominalism itself will perish before the latter. That the scientific point of view is a thoroughly objective one, and that the cosmical facts discovered by science can by no means be made to vanish in the universal solvent of Nominalistic subjectivism, easily appears. One or two illustrations will suffice. Jevons, in the Principles of Science 3d ed. A mathematician certainly does treat of symbols, but only as the instruments whereby to facilitate his reasoning concerning quantities; and as the axioms and rules of mathematical science must be verified in concrete objects in order that the calculations founded upon them may have any validity or utility, it follows that the ultimate objects of mathematical science are the things themselves. Signs, thoughts, and exterior objects may be regarded as parallel and analogous series of phenomena, and to treat any one of the three series is equivalent to treating either of the other series. Tyndall, in his Light and Electricity pp. The justification of a theory consists in its exclusive competence to account for phenomena. This substance is called the luminiferous ether. It fills space; it surrounds the atoms of bodies; it extends, without solution of continuity, through the humors of the eye. The molecules of luminous bodies are in a state of vibration. The vibrations are taken up by the ether, and transmitted through it in waves. These waves impinging on the retina excite the sensation. Cooke, in his New Chemistry, illustrates the same point still more strikingly and emphatically, with reference to the atomic theory: The new chemistry assumes as its fundamental postulate that the magnitudes we call molecules are realities; but this is the only postulate. Grant the postulate, and you will find that all the rest follows as a necessary deduction. Deny it, and the New Chemistry can have no meaning for you, and it is not worth your while to pursue the subject further. If, therefore, we would become imbued with the spirit of the new philosophy of chemistry, we must begin by believing in molecules; and, if I have succeeded in setting forth in a clear light the fundamental truth that the molecules of chemistry are definite masses of matter, whose weight can be accurately determined, our time has been well spent. Remembering that the weight of the hydrogen atom is taken as the unit of molecular weight, and that, according to calculations based on the figures of Sir William Thomson, this atom weighs approximately, in decimals of a gramme, 0. To consciousness it is equivalent to absolute zero; but the "New Chemistry" demands belief in it as an actual quantity in Nature, an objectively existent reality in a Cosmos not resolvable into consciousness by any Nominalistic legerdemain. It would be superfluous to cite further passages in order to illustrate the thoroughly objective spirit, method, and results of modern science, as contrasted with those of modern philosophy. All scientific investigations are founded on a theory diametrically opposed to that of Kant: This is the philosophical translation of the principle of verification. The Nominalism that inculcates the contrary doctrine is an excrescence upon modern philosophy, a cancerous tumor feeding upon its life. Science has achieved all its marvelous triumphs by practically denying the fundamental principle laid down by Kant, and by practically proceeding upon its exact opposite; and it is a scandal to philosophy that she has not yet legitimated this practical procedure, overwhelmingly justified as it is by its incontrovertible results. The time has come for philosophy to reverse the Roscellino-Kantian revolution, and give to science a theory of knowledge which shall render the scientific method, not practically successful for that it already is , but theoretically impregnable. The present article is the beginning of an attempt in that direction. A glance at the course of speculation in the past will render clearer the nature of the problem which philosophy has now to solve. The pre-Socratic philosophy of Greece was unqualified Realism, of a naive and primitive type. The Pythagoreans sought the causal unity of the universe in its most general relations, as number, proportion, harmony, order, law, which they conceived as at once the abstract and concrete directive force of nature; their cosmology was no less objective than that of their predecessors. The Eleatics, Xenophanes, Parmenides, Zeno of Elea, Melissus, maintained the principle of objective Monism; their en kai pan was illimitable and immutable Being, devoid of every positive attribute save that of thought, while the manifold appearances under which it presents itself to man were only mere seeming and delusion. But there was no element of subjectivism in their cosmology; they attributed to the Cosmos permanence without change, unity without multiplicity, as its constitutive objective principle.

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