CLASSIFICATION OF SCIENCES IN PIERRE DUHEM

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ABSTRACT

The sciences are parts of a great whole, to wit, the members of a magnificent system. Each of them has manifold relations to every other. Thus, there must be a science of the sciences, a science which determines the principles and conditions, the limits and relations, of the sciences. This science is philosophy which is the queen of all the sciences. One of the crucial problems with which philosophy should deal seems to be how may the sciences be rationally arranged and classified. Since before now there has been a continuous series of attempts to classify the sciences in philosophy. So, the classification of the sciences is one of the fundamental problems of philosophy and this paper is interested in setting forth Duhem's classification of sciences as sciences of reasoning, empirical sciences and historical sciences.

Keywords: *philosophy, science, classification, the sciences of reasoning, the experimental sciences and the historical sciences.*

PIERRE DUHEM'DE BİLİMLER SINIFLAMASI

ÖZET

Bilimler devasa bir bütünün parçalarıdırlar, diyeceğim, muhteşem bir dizgenin üyeleridirler. Bu parçaların her birinin biribirleriyle çoklu ilişkileri vardır. Şu halde, bilimlerin ilkelerini, koşullarını, sınırlarını ve birbirleriyle ilişkilerini belirleyip tayin eden bir başka bilimin olması gerekir. Bu bilim bütün bilimlerin kraliçesi olan felsefedir. İşte felsefenin ilgilenmesi gereken canalıcı problemlerden birisi bilimlerin ussal bir biçimde nasıl düzenlenip sınıflandırılacağı meselesidir. Felsefede öteden beri bilimleri sınıflama çabası hep olmuştur. Öyleyse, bilimlerin sınıflandırılması meselesi, felsefenin temel problemlerinden bir tanesidir; işte bu çalışma Pierre Duhem'in bilimleri; uslamlamalı, deneysel ve tarihsel bilimler olarak sınıflandırmasını gözler önüne serme çabasıdır.

Anahtar Kelimeler: *Felsefe, bilim, sınıflama, uslamlamalı, deneysel ve tarihsel bilimler*

Introduction

The very popular etymological approach is that philosophy is the love of wisdom. A more expansive approach stressing both the process of

philosophizing as well as the product is that philosophy is both the seeking of wisdom and the wisdom sought. An approach stressing the analytic nature of philosophy is that philosophy is the logical analysis of language, clarifying the meaning of words and concepts. There is another approach stating that philosophy deals with ultimate reality or with the most general causes and principles of things. In a nut shell, philosophy is a process of reflecting on and criticizing our most deeply held concepts and beliefs.

Philosophy is traditionally thought of as the discipline that discusses and attempts to resolve problems. Any subject, provided it is pursued far enough, will reveal philosophical problems. Philosophical problems are merely extensions of our everyday problems, heightened and focused by our sense of wonder and invariably posed in the form of the question. In addition to this, identifying, clarifying, classifying and analyzing problems have long been regarded as the tasks of philosophy. Like a doctor treating a problematic disease, the philosopher carefully observes a problem, noting its symptoms and distinguishing it from other problems. Ultimately, the philosopher attempts to treat or solve the problem. Just as it is unreasonable to blame a physician for causing a disease, it is a mistake to believe that philosophers are the causes of the problems they treat. Like physicians, philosophers play an important role in our society by identifying the ills that afflict us and educating us to treat ourselves. As a matter of fact philosophy originates in wonder about the problem of life, a wonder that leads us to question. Philosophical questions are those heightened expressions of our curiosity about ourselves and our world. Philosophy answers questions through a method known as dialectic, which may be thought of as the art of disciplined conversation. The use of dialectic can be traced back to Socrates, perhaps the best known of the early Greek philosophers. Since Socrates wrote nothing, we have come to learn of his 'Socratic Method' largely through the writings of his most famous student, Plato, who used the dialogue as his favorite form of writing, developing a style that proved to be highly conducive to dialectical reasoning. The idea is to clarify the meaning of some basic question by exchanging reasoned arguments and views on the subject with other interested persons (Scruton, 1996: 11-12).

Now historically, philosophers have identified three main branches of their discipline: epistemology, metaphysics and axiology.

The term epistemology is derived from the Greek word *episteme* meaning knowledge. Broadly speaking, epistemology is the branch of philosophy that studies the nature, sources, validity and limits of knowledge. As philosophers have wrestled with these questions through the years, two schools of thought have emerged: rationalism and empiricism. Rationalists believe that pure reason alone, unaided by the senses, is sufficient for obtaining reliable knowledge. Empiricists claim that all knowledge is ultimately derived from sense experience; hence, our knowledge of the world is restricted to what we can actually experience (Fetzer, 1993: 47-49).

The branch of philosophy that deals with the nature of reality is called metaphysics, which discusses the most universal principles and causes of things. Philosophers generally subdivide metaphysics into three main divisions: ontology, philosophical anthropology and philosophy of religion. Metaphysics attempts to construct a comprehensive view of all reality. It is concerned with some of the challenging and perplexing questions as follows: the origin and nature of space and time, the nature of change and causality, the nature of human person, freedom and determinism, the existence of God and the problem of evil (Baylis, 1965: 1-2).

Axiology is the branch of philosophy that deals with theory of value. It has traditionally been subdivided into ethics, social and political philosophy and aesthetics. Ethics is the discipline that attempts to establish rational grounds for right conduct (Thiroux, 1977: 1-2). Social and political philosophy examines the value judgments operative in the state and society. The central problem concerns the relation of the individual to the state (Reinhardt, 1962: 141, 162). Aesthetics is the philosophy of art and beauty. When we pass judgment on a work of art, we are expressing our sense of artistic value. A very important problem in aesthetics is the question of criteria. What are the criteria of good work of art? And also the question of what is the role of artist in society is very crucial in the philosophy of art (Collingwood, 1997: 7,9,11).

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In the seventeenth and eighteenth centuries, what is now called science fell under the category of natural philosophy. The modern use of the term science dates from the nineteenth century, which was also the century in which the term scientist was coined. During the early part of the twentieth century, a group of philosophers and scientists known as the Vienna Circle tried to place both philosophy and science on a more secure base. The philosophy of science that grew out of the Vienna Circle has come to be known as the 'received view' and is now the classic account of how science works. The questions that philosophy of science ask go as follows: What is science? What is the scientific method and how does it differ from the methods of literature, history and the like? How are the sciences to be rationally arranged and classified? It is this last question I shall try to spell out in detail by focusing on especially Pierre Duhem's classification of the sciences.

In this context, science is to be defined as a disciplined quest to understand nature in all its aspects and explains that it demands both open and complete exchange of ideas and data as well as an attitude of skepticism about its own tenets. It should also be stressed that scientific results must be capable of reproduction, modification and the like by independent observes. At this point, the Baconian survey of the sciences is a very celebrated one. Francis Bacon's schema's basis is a division of the faculties of the rational soul. These, according to Bacon, are three, namely, Memory, Imagination and Reason. From these three fountains flow these three emanations, namely, History, Poetry and

Philosophy. Memory, then, which accumulates facts, gives rise to History that is either Natural or Civil – either the works of nature or of the works of man. Natural History subdivides into the history of generations and of the arts. Civil History, in general, subdivides into literary, sacred and civil history; the first treating of the progress of literature and learning, the second of the church, prophecy, and providence and the third of the fortunes of states.

Imagination operates on sensible materials, combining, magnifying and idealizing them at pleasure, and so gives rise to Poetry which subdivides into Narrative Poetry, Dramatic Poetry and Parabolical Poetry.

Reason operates on things by analysis and classification by abstraction and generalization and so produces Philosophy which has three objects, namely, God, Nature and Man. He also calls them as the doctrine of the Deity, the doctrine of Nature and the doctrine of Man. Bacon does not subdivide the doctrine of Deity or Natural Theology. The doctrine of Nature or Natural Philosophy he first separates into Speculative and Practical; then, subdivides the speculative branch into Physics and Metaphysics; and the practical branch into Mechanics and what he calls Magic, which answers in some measure to Experimental Science. To Natural Philosophy, Speculative and Practical, he adds Mathematics, Pure and Applied but not an independent science.

The doctrine of Man he divides into Human and Civil Philosophy. Human Philosophy he distributes into a doctrine of the body, a doctrine of the soul and a doctrine of the things common to the body and the soul. Civil Philosophy he divides into the Art of Conversation, the Art of Negotiation and the Art of State Policy.

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The greatest English philosophical contemporary of Bacon, Thomas Hobbes also attempted a classification of the sciences and his classification, although it has been little remarked, is, in reality, very remarkable. In chapter 9 of *Leviathan*, he says Knowledge is of two kinds, to wit, knowledge of facts and of the consequences of one affirmation to another. The knowledge of facts gives rise to history and history is either natural history or civil history. The knowledge of consequences causes to happen science whose primary division is into Natural Philosophy and Civil Philosophy. Natural Philosophy is, in its turn, divided in a twofold manner, according as the consequences of which it consists are drawn from accidents common to all bodies which are quantity and motion or from the qualities of bodies. Consequences from quantity and motion indeterminate constitute Primary Philosophy; from quantity and motion determined by figure, Geometry; from quantity and motion determined by number, Arithmetic; from quantity and motion of bodies in special, if the larger parts of the world, as the earth and stars, Geography and Astronomy; for special kinds of motions and special figures of bodies, Engineering, Architecture, Navigation, etc. Then, going back to physics or consequences from the qualities of bodies permanent. Among permanent bodies are the stars, from where

Sciography conversant with their light and Astrology conversant with their influences; the ether, from where a science of atmospheric fluids; terrestrial bodies, which are either non-sentient or sentient. Consequences drawn from parts of the earth without sense are Mineralogy and Botany: the one conversant with the qualities of minerals and the other with the qualities of plants. Consequences from the qualities of animals are either of animals in general or men in special. If of animals in general, Optics is knowledge of consequences from vision; Music of consequences from sound and some unnamed science or sciences of consequences from the rest of the senses. If of men in special, then, knowledge of consequences from the passions is Ethics; from speech in magnifying, vilifying, etc., Poetry; in persuading, Rhetoric; in reasoning, Logic; in contracting, the Science of Just and Unjust. Civil Philosophy Hobbes did not subdivide into more special sciences.

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Descartes' most explicit passage regarding the subject in question in his writings, namely, in *Principles of Philosophy*, is the following: when a man has acquired some skill in discovering truth, he should commence to apply himself in earnest to true philosophy, of the first part is metaphysics, containing the principles of knowledge, among which is the explication of the principal attributes of God, of the immortality of the soul and of all the clear and simple notions that are in us. The second is Physics, in which, after finding the true principles of material things, we examine, in general, how the whole universe has been framed; in the next place, we consider, in particular, the nature of the earth and of all the bodies that are most generally found upon it, as air, water, fire, the loadstone and other minerals; in the next place, it is necessary also to examine singly the nature of plants, of animals and above all of man, in order that we may thereafter be able to discover the other sciences that are useful to us. Thus, all Philosophy is like a tree, of which Metaphysics is the root, Physics the trunk and all the other sciences the branches that grow out of this trunk, which are reduced to three principles, namely, Medicine, Mechanics and Morals (ethics).

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John Locke treats "of the division of the sciences" in the last chapter of *Essay concerning Human Understanding*. Locke rightly judged that the consideration of that subject would be a fitting conclusion to such an inquiry into the origin and nature of knowledge as he had instituted. The division adopted was threefold, namely, Physica, Practica, Semeiotica; for a man can employ his thoughts about nothing, but either the contemplation of things themselves for the discovery of truth or about the things in his own power, which are his own actions for the attainment of his own ends or the signs the mind makes use of both in the one and the other and the right ordering of them for its clearer information.

I. Physics, in the wide sense in which the term is used by Locke, is the knowledge of things as they are in their own proper being, their constitution, properties and operations; it has for end bare speculative truth and whatsoever can afford the mind of man any such, falls under this branch, whether it be God himself, angels, spirits, bodies or any of their affections.

II. Practics is the skill of right applying our own powers and actions for the attainment of things good and useful. Its chief branch is Ethics, the seeking out those measures and rules of human actions which lead to happiness and the means to practice them.

III. Semeiotics is the doctrine of signs and includes Logic or the doctrine of words, these being the signs which the mind makes use of for the understanding of things or conveying its knowledge to others.

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Leibniz, in the last chapter of the *New Essays concerning Human Understanding*, criticized the classification of Locke and the classification proposed by him is one of books. Putting differently, his nearest approach to a classification of the sciences is included in a plan for the catalogue of a library, that is, *Idea Leibnitiana Bibliothecae ordinandae contractior*.

His classes are as follows:

1. Theology;
2. Jurisprudence;
3. Medicine;
4. Intellectual Philosophy, which is either Theoretical (Logic, Metaphysics, Pneumatics) or Practical (Ethics and Politics);
5. Mathematical Philosophy, which includes not only Pure Mathematics, but Astronomy, Mechanics and all sciences specially dependent on vigour of imagination;
6. Physical Philosophy, comprehending Physics Proper, Chemistry, Mineralogy, Botany, Zoology and all sciences which rest on a knowledge of the things of sense;
7. Philology;
8. History;
9. Miscellanies.

According to this arrangement, all knowledge belonging to the three faculties of Theology, Law and Medicine is severed and separated from Philosophy or Science, Philology and History.

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According to the Italian philosopher, Giambattista Vico, the order of social evolution is a necessary order determined by the advance of reason. Hence, a law of three periods of history through which all sciences and arts, ideas and institutions naturally pass. The periods are designated by Vico the Divine, the Heroic and the Human and the root of each is described by him as a peculiar mode of conception or form of wisdom. Therefore, he maintains, there

are three stages of science, three kinds of nature, three types of character, three epochs of religion, three species of language, of writing, of governments, of natural law, of jurisprudence and so on.

The New Science which Vico claimed to have founded he maintained to be the central and regulative science. He regarded his discovery of it as not merely an addition to the sciences but a revolution in the whole system of the sciences, in as much as it showed that not metaphysics or physics, but the science of the development of the human mind in history was the fundamental and governing science. In his view the science of history was the most comprehensive science and all other sciences were rooted or included in it and had their character and rank determined by their relationship to it. All science, he held, is the production of the human mind; the whole science of any age is only a transient stage in the history of the human mind; the perfect state of a science is but the last period of its history; therefore, the science of history is not merely a special and rather limited science, but an all-comprehensive science, the true science of the sciences. It is so because the fundamental, constitutive and regulative principles of all science is not the abstract, transcendent, objective but the actual, immanent, subjective – the all-productive reason.

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In his *Positive Philosophy Courses*, Auguste Comte puts forward the famous "law of three states" meaning that the human mind in every department of thought and inquiry reaches such relative truth as it can attain and so enters into the state called positive or, in other words, arrives at science only by passing through a theological and metaphysical state. Thus apprehended, the law necessarily implies that there can be no true theology or true metaphysics. Now, Comte distributed the sciences into two classes as follows: Abstract Sciences conversant with general laws and Concrete Sciences conversant with the explanation of particular existing things by means of general laws; and Comte felt the former only to be fundamental and alone to require from the philosopher classification.

The Abstract Sciences, Comte held, must fall into a single linear series, each member of which has its place determined by its relative simplicity, generality and independence. This does not prevent them from being divisible into Mathematical and Physical or the Physical Sciences from being divisible into Inorganic Physics comprehending Astronomy and Physics proper and Organic Physics containing Biology and Sociology; but it implies that Mathematical Science must precede Physical Science and that the five fundamentally distinct Physical Sciences must have been evolved in the following order: Astronomy, Physics, Chemistry, Biology and Sociology. A relatively simple, abstract and independent science must always precede one which is more special, complex and dependent.

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Now, philosopher, physicist and historian of science Pierre Duhem (1861-1916) is a major influence in twentieth-century thought. Lately, there has been a revival of interest in his philosophy. Duhem has been a major influence in twentieth century thought, a source for key ideas in the philosophy of science. Duhem's view of the proper role of science seems to be based on the Pascalian premisses, namely, *principles are intuited; propositions are inferred*. For him, the search for truth requires both good sense, i.e., an intuitive quality; and rigorous deduction. Accordingly, I am of the opinion that Duhem's views on the classification of the sciences spelled out by him in his book *German Science* are crucial importance for understanding Duhem's idea of science(s).

A) *The Sciences of Reasoning*

Duhem argues that everyone has studied, to some degree, the principles of arithmetic or geometry. It is, thus, common knowledge that the propositions of which these sciences are composed are divided into two categories; that is, a few axioms comprise one category; innumerable theorems make up the other. In Duhem's view, of the sciences of reasoning, arithmetic and geometry are the most simple and, consequently, the most completely perfected. In each of the latter sciences we ought likewise to distinguish theorems from axioms.

Axioms are the sources, the principles, of theorems, as such, deductive reasoning proceeds by rules which, for the human mind, are like spontaneous effects of the natural instinct but analyzed and formulated by logic, obliging whoever accepts the truth of the axioms to admit equally the theorems which are their consequences (Duhem, 1991: 6). Duhem goes on to state that axioms are drawn from common knowledge, to wit, every rational man holds their truth to be certain before studying the science the foundations of which they will become. However, it is not the same with a theorem. Someone who has not studied arithmetic will not know if he is confronted with an error or a truth when he hears this proposition following: "the least common multiple of two numbers is the quotient of their product divided by their greatest common factor". His uncertainty will be the same if he does not know geometry and we told him that the measure of the volume of a sphere is equal to the product of its surface multiplied by one-third of the radius. In order for him to come to regard these propositions as quite certain truths, he must patiently pass through a long sequence of reasoning that will demonstrate him one step at a time how the certainty possessed by the axioms is transmitted to the theorems (Duhem, 1991: 7).

Duhem keeps going by arguing that to indicate the immediately obvious character of axiomatic evidence, we readily compare its obviousness to perception; then, we say that we see that such a proposition is true, whose certitude is evident. Hence, the faculty by which we know the axioms is given the name of "sense", i.e., it is common sense, or good sense. In other words, it is the feeling for the truth, which we feel immediately when our attention falls upon a principle (Duhem, 1991: 7). Good sense is for the intuitive perception of

the obviousness of the axioms and the deductive method to arrive by the rigorous but slow progress of discourse at the demonstration of the theorems; there we have the two means that human intelligence employs when it wishes to construct a science of reasoning (Duhem, 1991: 8).

To Duhem, deductive reasoning advances no proposition until it has rigorously demonstrated all the preceding ones and the new proposition will not be established with any less care. The slow and prudent procedure of the deductive method, which only advances one step at a time, each of whose forward movements must obey the rigorous discipline imposed on it by the rules of logic (Duhem, 1991: 9-10). Of all the sciences, that which best satisfies this tendency is algebra. All of algebra, in fact, is no more than an immense prolongation of arithmetic, and the deductive method is all that is necessary to produce this prodigious development. The only axioms which algebra needs are thus the axioms on which arithmetic is based, to wit, a quite small number of extremely simple and glaringly obvious propositions concerning the addition of whole numbers (Duhem, 1991: 11-14).

Subsequently, Duhem puts forward that there are two sources of certitude; namely, propositions receive their certitude from demonstration and principles take theirs from common knowledge. Hence, the latter is not of a different value or kind from the former and, as a result, both are equally certain. In other words, we ought to say that there is a single source from which all certitude flows, the source that provides certitude to principles. As a matter of fact, the principle of certitude is located in the intuitive knowledge which derives from common sense (Duhem, 1991: 15-16). That's why, Duhem asserts that in the mind with the absence of common sense or of good sense, reasoning banishes reason (Duhem, 1991: 20).

In a few words, it seems that, for Duhem, in algebra and geometry as well as in metaphysics when it is soundly constructed, the axioms are utterly simple. Once our attention is fixed upon any one of them, immediately the sense of it becomes perfectly clear to us, and its certitude fully warranted. Consequently, in these sciences, the principles are evident.

B) *The Experimental Sciences*

According to Duhem, things are quite different with the experimental sciences in which the principles are not called axioms any more but rather hypotheses or suppositions, which must be understood in their etymological sense, to wit, foundations. In fact, these are also called experimental laws or truths of observation. Yet, simply paying attention to the statement of a hypothesis or a law does not in any way let us hold it to be true. It would be valid to assent to it only after the complex and prolonged labor of experiment testing it. At this point Duhem asks a very crucial question as follows: how could one deduce from experiment a hypothesis appropriate to play the role of principle in an observational science (Duhem, 1991: 21-22)?

Duhem sets forth Louis Pasteur's working manner in experiment to reply the question put forward above. So, Pasteur arrives at the laboratory having in his head a "preconceived idea", to wit, a proposition which he willed to submit experimental verification. His assistants, under his direction, prepared experiments which, according to that preconceived idea, ought to produce certain results. Most of the time the desired or expected results were not those which the experiment *de facto* produced. Then, the experiments were gone over the same ground with greater care. Another failure; and then a third endeavor was undertaken, only to result in a further failure. The laboratory assistants were often astounded at the stubbornness of "the man", intoxicated by the pursuit of the consequences of what was clearly a faulty preconception. At last a day came when Pasteur proclaimed an idea different from the one which experiment condemned. Then, one appreciated the fact that none of the contradictions to which the latter had led had been in vain; for each of them had been taken into consideration in the formation of the new hypothesis. It, in its turn, had its corollaries put to the test of facts and more often than not the process resulted in new failures. However, in the process of sorting out this hypothesis, these failures prepared the conception of a new idea. Thus, step by step, through this kind of conflict between preconceived ideas that proposed experiments, and the experiments that restrainted the preconceived ideas to be transformed, a hypothesis was constructed which conformed perfectly with the facts and was capable of being accepted as a new law of physiology (Duhem, 1991: 22-23).

According to Duhem, in this work of successive improvements upon an initial necessarily rash and often false idea which finally leads to a fruitful hypothesis, the deductive method and intuition each play their role. In order to make out of the preconceived idea conclusions to be compared with facts, which experimental proof will either confirm or condemn, one must deduce. Such deduction is often a quite long and delicate process. It is essential that it be a rigorous process, under pain of making the observational testing depend on propositions which could not be derived from the hypothesis, and thus of rendering this testing illusory. However, this reasoning cannot be conducted in geometrical or mathematical way, under the form of a series of theorems. The proposition, the consequences of which one wills to deduce, would not lend itself to this process. The ideas on which it relies are no longer highly abstract but quite simple concepts, like the first objects of the mathematical sciences, or ideas made in a well-known fashion by definition using those concepts. These are ideas richer in content but less precise, less analyzed; they issue more immediately from observations. To reason exactly with such ideas, the rules of syllogistic logic are not adequate. They must be assisted by a certain sense of soundness that is one of the forms of good sense. In another way, again, good sense will intervene at the moment at which one realizes that the outcomes of a preconceived idea are either contradicted or confirmed by the experiment. This

realization is indeed far from being entirely simple; the confirmation or contradiction is not always explicit and straightforward (Duhem, 1991: 23).

As has been figured out, from his preconceived idea an experimenter such as Louis Pasteur draws this conclusion: if one injects one particular substance into rabbits, they will die. The control animals which have not had the injection will stay in good health. But this observer is aware that a rabbit might die, at times, from other causes than the injection, the effects of which are being studied. He knows equally that certain particularly resistant animals can sustain doses of an injection which would kill most of their fellows, or further, that an inept administration can impair the injection and render it inoffensive. If, then, he sees one inoculated rabbit live or one control animal die, he need not conclude directly and overtly to the falsity of his preconceived idea. He could be faced with some accident of the experiment which need not require the abandonment of his idea. What will determine whether these failures are or are not of such a nature that the supposition in question must be renounced? Good sense. Good sense will not return its verdict until after having weighed the *pros* and *cons* with mature consideration. Guaranteeing the soundness of still-imprecise processes of reasoning by means of which results capable of being proved by experiment are drawn from a preconceived idea, and estimating whether such proof ought to be taken as indicative or not, do not exhaust the task which devolves upon good sense (Duhem, 1991: 25).

When the factual proof has turned against the preconceived idea, it is not enough simply to reject it. One must substitute for it a new supposition which has the possibility of standing up better to experimental testing. Here it is necessary (Pasteur excelled in doing this) to pay attention to what each of the observations which have condemned the initial idea suggests, to interpret each of the failures which destroyed that idea, and to synthesize all these lessons for the purpose of fabricating a new thought which will pass once again under the scrutiny of the actual results. Truly, in order to perform this well, it is necessary that good sense should transcend itself, to wit, push its strength and its suppleness to their very limits, that it becomes what Pascal called the intuitive mind. In Mathematical mind, Pascal voiced, one sees the principles fully, and one must have a quite inaccurate mind who reasons wrongly from principles so plain that it is almost out of the question that they should escape notice. But in the intuitive mind the principles are found in common use, and are before the eyes of everybody. One has only to look, and no effort is necessary; it is only a question of good eyesight, but it must be good, for the principles are so subtle and so numerous (Duhem, 1991: 24-25).

Duhem goes on to say that when an experimental science has come to the point of perfection at which deductive reasoning unrolls at length the consequences of hypotheses, or, better yet, when it lends itself to the use of mathematical reasoning, it allows man to foresee exactly what will be produced in given circumstances, and its expectations are almost assured against failure.

Now, foresight is power. Hence, experimental science, when it has become deductive, above all when it has become mathematical, is the guide of industry. From this point, in order to promote industry, the mathematical mind must draw out all the corollaries entailed in the principles of science so that the engineer may find among the corollaries a mass of useful truths, practical recipes, and patentable processes (Duhem, 1991: 35)

Accordingly, Duhem asserts that a science whose principles have been drawn from experiment still remains adjudicable by experiment. When, then, it comes to taking some of the consequences deduced from theory and comparing them with the facts, the observer ought to inquire into reality with as much care and impartiality as if the process of reasoning involved had not offered him any preliminary indication. His attention ought to be brought to bear with a particular sharpness on every fact which, insignificant as it might appear, deviates from what has been predicted. His intuitive mind ought to collect and weigh these evidences with scrupulous precision if these contradictions of what was expected should demand it, to condemn the theory, despite all the confirmation it may previously have received (Duhem, 1991: 36).

As a matter of fact, Duhem argues that the theories do not always display such willingless ready to agree. Complete as they may be, and well tested by previous experiment, they endlessly reveal themselves as over-simple. Reality is so ample and so complex that the theories are outflanked by it in all respects. Never can the sagacious observer pursue the testing of a theory for a considerable period of time without discovering unforeseen, difficult, or exceptional cases, upon which his subtlety of spirit finds many occasions to exercise itself. To sum up the matter in a few words, for Duhem, it is not a some kind of game that "here everyone wins; seeing at each throw that the dice bring a double-six, will you exclaim, with Pascal, that the dice are loaded?" (Duhem, 1991: 37).

C) *The Historical Sciences*

Duhem sets to work by stating that historical truth is a truth of experiment. In order to recognize or to disclose an historical truth, the mind follows exactly the same path as it does to disclose experimental truth. However, rather than observing facts, history studies monuments, it deciphers texts. Besides, these monuments and these texts are themselves also facts. According to Duhem, at the beginning of all historical reasearch, as at the beginning of all experimental research, a "preconceived idea" is necessary. This idea has often been suggested to the historian through some lucky find, for example, the discovery of some monument until now buried in the ground, or of some unknown text, which chance brings him to dig up in the debris of an ancient city or the dust of a library (Duhem, 1991: 41).

It is necessary to submit this preconceived idea to the control of the documents and, in order to do that, one must research these documents. Such research is often difficult, always entrancing, but has no precise rule to direct it.

In it one rediscovers the fascination and the unpredictability of the chase. Precisely where everything appears to promise a rich quarry one finds the thicket empty, and the game takes off from its cover where one never thought to come across it. Directing such a chase smacks so little of the reasoning of reason that it is tempting to compare the skillful searcher of excavations and archives to a dog going after a scent, and to say of such a person that he has a talent for such things (Duhem, 1991: 41-42).

One must make use of the documents collected. Each of them necessitates, then, a discerning scrutiny to figure out if it is authentic; if it is complete; if it is candid and so on. Above all, regarding the author of the so-called documents or texts the following questions and the like are crucial: has he said, without addition and without reserve, all that he thought to be true? Did his passions and his interests not lead him to exaggerate or conceal or modify part of the events which he retold? In Duhem's view, in the presence of a text, the historian ought to be like the examining judge confronted by a witness who saw things inaccurately, or who obstinately refuses to recount what he saw, or who chooses to invent things which he did not see. However, the judge by virtue of prudent, patient, skillfully-connected questions, ends by drawing out of this ignorant or recalcitrant or dissembling witness precise, truthful, and useful information (Duhem, 1991: 42-43).

Duhem puts forward that when one has forced the texts to speak, then it is necessary to listen to their language. On the other hand, Duhem argues that in the realm of every science, but more particularly in the realm of history, the pursuit of the truth not only requires intellectual abilities, but also calls for moral qualities such as rectitude, probity, detachment from all interest all passions. He also states that once our initial supposition has been rejected, we must make another one, which takes account of all the texts and all the monuments already known. Then, if possible, we must check this second proposition against new documents. In such fashion, by the continual comparison of our thought with facts, by this incessant impression of facts upon our thought, little by little, a historical truth will be found to disengage itself, to become explicit, to become clear (Duhem 1991: 43-44).

In fact, historical work essentially requires the intuitive mind for its accomplishment. It is appropriate that one say of such research that its principles are found in common use and are open to the scrutiny of everybody. One has only to look and no effort is necessary; it is only a question of good eyesight, but the eyesight must indeed be good, for the principles are so subtle and so numerous that it is almost out of the question but that some escape notice. Now the omission of the principle leads to error; thus one must have very clear sight to see all the principles and then accurate mind not to draw false deductions from known principles. That's why, Duhem asserts that there is not, there cannot be any historical method. Otherwise, the state of affairs would be as follows: the entirety of the rules that transform the critique of the historian

into well-regulated mechanically functioning clockwork have been offered to the admiration of the world under the name of historical method. Hence, intellects most lacking in subtlety and most deprived of common sense had only to follow them to get at unerringly truth (Duhem, 1991: 44).

According to Duhem, whoever voices or sounds method says a manner of procedure gone after with precision capable of leading without deviation from one limit to another. In the arts, method exists wherever there is an explicitly formulated procedure which, with the help of specific means, allows one to execute unerringly a prescribed work. In mental operations, method exists if reason possesses a rule of conduct which leads it faultlessly from the knowledge of certain given truths to the discovery of other truths which are necessary consequences of those given truths. Duhem cites Aristotle to shed light this point by stating that Aristotle's definition of a syllogism goes like following: a process of reasoning in which, certain things being given, something else necessarily follows by reason of the nature alone of the given things themselves.

As Duhem has it, this is as much as to say that, in the realm of the intellect, method is synonymous with reasoning syllogistically and that it is exclusively deductive. Method takes possession of a science, then, precisely at the moment that this science comes under the sway of the mathematical mind. Insofar as the progress of a science relies on subtlety of mind alone, that science is in revolt against all method (Duhem, 1991: 45).

Duhem goes on to say that there is a general method of deduction, of which Aristotle permanently established the laws. There is a method particular to each of the sciences which deduction develops: a method for Algebra, one for Geometry, one for Mechanics and Mathematical Physics. From the day the atomic notation allowed one to say, by means of precise rules, by what series of reactions one could unerringly bring about this substitution or that synthesis, there was a chemical method.

Hence, there will be no historical method at all as long as history does not proceed by deduction; and history will never be a deductive science because man, its subject, is too complex, altogether too difficult top in down with any definition, moving as he does in a milieu of events too numerous, too fine, too confused to be measured. The best-placed witness has not seen everything. Who will specify the concourse of trifling circumstances thanks to which a given fact escaped him? This general did not notice a certain episode of the battle for which he was responsible: he was busy controlling his horse, which had just been bitten by a fly (Duhem, 1991: 45-46).

As figured out clearly, the most veracious witness does not report everything he has seen; he relates only that which appears to him to be worth noting. Does one expect then to attain by rigorous reason to the exact connection between what he saw and what he reported? Where in this process are those simple ideas, those clearly defined notions, to be found? Those few

rudimentary principles without which the deductive method cannot be followed? For Duhem, another reason bans history the use of the deductive method? In order for a science to be able to become deductive it is necessary that, in the realm which it explores, the consequences must follow necessarily from the data. It is necessary that this realm be governed by a rigorous determinism.

So, one can never deduce in history; never affirm that such causes that are known have necessarily produced such a result. Always, indeed, the human will is inserted between causes and that which comes of them and this will is free. Duhem argues that for historical criticism to function with the same surety and precision as a well-regulated mechanism, it would be necessary that man himself be a machine, that he have the simple and rigid wheelwork of a machine and its necessary movement (Duhem, 1991: 46).

According to Duhem, perhaps one will say that science has changed a lot since the time that these great men wrote. Science, yes, but not the manner of doing science, or at least doing it well. We are not supposed to believe those who repeat: we reason completely differently from, and better than, our ancestors. In every age one comes across those presumptuous persons who affirm that, before them, the human intellect was in its infancy, and that with them alone it has left its apron-strings behind. This a handy doctrine for those lazy ones whom it dispenses from studying the works of the past, or for the impudently vain whom it authorizes to give out old ideas as novelties. But it is a doctrine which collapses at the least glance over the history of the sciences. From Plato to our times the faculties which the human reason has at its disposition in order to search for truth have remained the same. And if our mind bit by bit brings to perfection the art of studying this or that subject it does so with extreme slowness and imperceptible progress. It could be told us, for instance, that true method in the biological sciences only dates from yesterday.

"However, take the memoir on physiology in which, in 1651, Jean Pecquet of Dieppe, … and painstakingly conducted experiments, set forth the laws of lymphatic circulation, and verified the laws of the circulation of the blood which anatomy had revealed a short while before to William Harvey. Next to this short treatise put one of the well-wrought works of Claude Bernard. During the two centuries that separate Bernard from Pecquet, physiological knowledge has developed remarkably; but the art of reasoning well in physiology has not changed. Every time, then, that we wish to assist a science to progress directly and soundly, go to school with those who made the first steps in it" (Duhem, 1991: 71-72).

For Duhem, it is essential that we read the classics of science, and assuredly, the men who have conducted their reason in a perfectly proper manner, who have maintained the most exact balance between their diverse faculties, have been more numerous among us than in any other land on earth. For the good of the human intelligence, God has willed that no one nation

should have the exclusive prerogative of these qualities. He has willed that each and every people should be able to discover with legitimate pride some geniuses among them in whom intuition and deduction should be developed with equal amplitude and harmoniously proportioned (Duhem, 1991: 72). In other words, taken in its essence, considered under its perfect form, science ought to be absolutely impersonal. Since no discovery in it would bear the signature of its author, neither would anything allow one to say in what land the discovery saw the light of day. But this perfect form of science could not be obtained without a quite exact sorting out of the various methods which come together to reveal the truth. Each of the many faculties which human reason puts in play when it wishes to know more, and better, would need to play its role, without any being omitted, without any being overtaxed. Duhem goes on to say that we do not come across this perfect equilibrium between the many organs of reason in any one man. In each of us, one faculty is more powerful, and another more weak. In the conquest of truth, the weaker faculty will not contribute as much as it should, and the more powerful faculty will take on more than its share (Duhem, 1991: 79).

Duhem goes on to put forward that in every science which has taken the form that we might call rational, or better yet, the form that might be called mathematical, we must, in fact, distinguish two strategies, namely, that which seizes on principles, and that which arrives at conclusions. The method that, from principles, ends with conclusions, is the deductive method, followed with the most rigorous precision. The method that leads to the formulation of principles is much more complex and difficult to define. As a matter of fact, common experience is the material from which induction draws the axioms. Deduction will draw out all the truths such universal propositions contain. Now, the choice of axioms is an operation of extreme delicacy. The axioms must suffice to justify all the propositions of the science that we wish to extract from them. The chain of reasoning must not suddenly have its continuity broken and its rigor compromised hidden in the data of experience and has not yet been formulated explicitly. It is equally necesary that there not be too many principles, that a simple corollary of an axiom be not given as itself an axiom. Consequently, Duhem states that more complex yet is the choice of hypotheses upon which will rest the entire edifice of a doctrine belonging to experimental science, of a theory of mechanics or physics. Here the matter which ought to furnish the principles is no longer common experience, spontaneously available to every man from the time he leaves infancy. It is scientific experiment. To the mathematical sciences common experience furnishes autonomous, rigorous, definitive data. The data of scientific experiment are only approximate. The continual improvement of instruments increasingly modifies them, while the fortunate chance of discovery each day comes to enlarge the treasury with some new fact (Duhem, 1991: 81-82). As a result, Duhem spells out that "far from being autonomous, or immediately intelligible in themselves, the propositions

which formulate the results of an experiment in physics or chemistry only have meaning if the accepted theories supply translations for them" (Duhem, 1991: 82).

It strikes me that it is worth pointing out what Duhem spells out right below:

"the hypotheses upon which any theory whatsoever of mechanics or mathematical physics rests are fruits whose maturity has been prepared over a long period of time. Data of common observation, results of scientific experiment assisted by instruments, ancient theories now forgotten or rejected, metaphysical systems, and even religious beliefs have contributed to them. Their effects are so intersected, their influences so mixed in so complex a manner, that a great subtlety of mind, sustained by a profound knowledge of history, is required in order to discriminate the essential direction of the path that has led human reason to the clear perception of a principle of physics" (Duhem, 1991: 92).

According to Duhem, the absence of the intuitive mind leaves a gaping abyss there between the development of ideas and the observation of the facts. Ideas are deduced one from another, proudly contradicting the common sense to which they owe nothing. Common sense manipulates realities and sets forth facts by its own proper means, without concern for a theory which ignores it or comes into collision with it (Duhem, 1991: 97). However, between the abstractions that the theoretician considers in his processes of reasoning and the concrete bodies that the observer manipulates in the laboratory, it is the intuitive mind alone that perceives an analogy and establishes a correspondence. So, the connection between theoretical physics and experimental physics is intuited, not inferred (Duhem, 1991: 101).

Duhem goes on to say that the rigor of science is not its truth. The intuitive mind alone judges if the principles of the deduction are admissible, if the consequences of demonstration are conformable to reality. For science to be true, it is not sufficient that it be rigorous; it must start from good sense, only in order to return to good sense (Duhem, 1991: 111).

Duhem argues that the historical method and study is the legitimate, sure and fertile method of preparing the mind to understand and accept a physical (scientific) hypothesis.

In conclusion, Duhem argues that science is powerless to establish the legitimacy of the principles which underly its methods and direct its investigations, unless it has recourse to common sense; at the foundations of our most clearly formulated doctrines, deduced with the greatest rigor, we discover again and again this confused aggregate of tendencies, aspirations, intuitions; no analysis is penetrating enough to separate them from each other, to decompose them in elements which are more simple; no language is precise and supple enough to define and formulate them; and yet, the truths which this common sense reveals to us are so clear and so certain that we can neither misunderstand

nor doubt them; much more, indeed, all scientific clarity and certitude are a reflection of their clarity and a prolongation of their certitude (Lowinger, 1941: 76). In other words, the consistency and unity of physics cannot be justified on the grounds of pure logic or by the principles of intellectual economy. Like all other methodological principles and rules of physical research, they can only be justified by common sense.

In a nut shell, science and the meaning and certitude of science are derived from irrational sources, tendencies, aspirations, intuitions that cannot be analyzed by our reason and formulated in language. Duhem also argued that religion played a positive role in the development of science in the Latin West. Whatever Duhem's initial motivation, his historical and philosophical work took on a life of its own, ranging over such diverse topics as the relations between the history of science and the philosophy of science, the nature of conceptual change, the historical structure of scientific knowledge and the relations between science and religion.

REFERENCES

BACON, Francis (1906), *The Advancement of Learning*, Oxford University Press, London.

BACON, Francis (1960), *The New Organon*, Bobbs-Merrill, Indianapolis.

BAYLES, Charles A. (1965), *Metaphysics*, The Macmillan Company, London.

BOCHENSKI, J.M. (1968), *The Methods of Contemporary Thought*, Harper Torchbooks, New York.

COLLINGWOOD, R.G. (1997), *Outlines of a Philosophy of Art*, Thoemmes Press, Bristol.

COMTE, August (1988), *Introduction to Positive Philosophy*, (trans. by Frederick Ferre), Hackett Publishing Company, Cambridge.

DESCARTES, Rene (1955), *Philosophical Works of Descartes*, (trans. by E. Haldane and G. R. T. Ross), Dover, New York.

DUHEM, Pierre (1954), *The Aim and Structure of Physical Theory*, Princeton University Press, Princeton.

DUHEM, Pierre (1991), *German Science* (trans. by John Lyon), Open Court Publishing Company, La Salle.

FETZER, James H. (1993), *Glossary of Epistemology/Philosophy of Science*, Paragon House Pub. New York.

HOBBES, Thomas (1962), *Leviathan*, William Collins, London.

LEIBNIZ, G. (1996), *New Essays Concerning Human Understanding* (trans. by. Peter Remnant), Cambridge University Press, Cambridge.

LOCKE, John (1965), *An Essay Concerning Human Understanding*, Everyman's Library, London.

LOSEE, John (1993), *A Historical Introduction to the Philosophy of Science*, Oxford University Press, Oxford.

LOWINGER, Armand **(**1941), The Methodology of Pierre Duhem, *Columbia University Press, New York.*

REINHARDT, Kurt F. (1962), *A Realistic Philosophy*, Frederick Ungar Publishing Com., New York

SCRUTON, Roger (1996), *An Intelligent Person's Guide to Philosophy*, Duckworth, London.

THIROUX, Jacques P. (1977), *Ethics*, Glencoe Press, London.

THOMPSON, Mel (2003), *Philosophy of Science*, Contemporary Books, Chicago.

VICO, Giambattista (1970), *The New Science of Giambattista Vico*, New York, Ithaca.

YOLTON, John W. (1965), *Theory of Knowledge*, The Macmillan Company, New York.

ÜNİVERSİTE ÖĞRENCİLERİNİN İŞGÜCÜ PİYASASINA YÖNELİK BEKLENTİLERİ VE İŞ DENEYİMLERİ İLE UMUTSUZLUK VE KAYGI DÜZEYLERİ ARASINDAKİ İLİŞKİ ÜZERİNE BİR ARAŞTIRMA[1]

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ÖZET

Bu çalışma, üniversite son sınıfta eğitim gören öğrencilerin, kaygı ve umutsuzluk düzeylerini ortaya çıkarmak, ayrıca öğrencilerin işgücü piyasasına yönelik beklenti ve iş deneyimi ile durumluk-sürekli kaygı ve umutsuzluk düzeyleri arasındaki ilişkiyi tespit etmek amacıyla yapılmıştır. Bu araştırmanın örneklemini, bir fakültede son sınıfta eğitim gören 105'i erkek ve 170'i kız olmak üzere 275 öğrenci oluşturmaktadır. Araştırmada öğrencilerin umutsuzluk düzeylerini belirlemek amacıyla Beck ve diğerleri (1974) tarafından geliştirilen "Beck Umutsuzluk Ölçeği", bireylerin durumluk ve sürekli kaygı düzeylerini belirlemek amacıyla Spielberger ve arkadaşları tarafından (1964) geliştirilen "Spielberger Durumluk-Sürekli Kaygı Ölçeği" kullanılmıştır. Verilerin değerlendirilmesinde, tek yönlü Anova, t testi ve F testi kullanılmıştır. Yapılan analizler sonucu öğrencilerin durumluk ve sürekli kaygı düzeyleri sırasıyla, 41,63±10,70 ve 42,21±8,65; umutsuzluk düzeyleri ise 4,25±3,93 olarak bulunmuştur. Elde edilen bulgulara göre, iş bulma ümidi, iş önceliği ile umutsuzluk ve durumluk ve sürekli kaygı düzeyleri arasında; diğer taraftan iş deneyimi ile umutsuzluk ve sürekli kaygı düzeyleri arasında anlamlı bir farklılık tespit edilmiştir. Ayrıca, cinsiyet açısından öğrencilerin kaygı ve umutsuzluk düzeyleri arasında anlamlı farklılıklar bulunmuştur.

Anahtar Kelimeler: *Üniversite Gençliği, İş Bulma Ümidi, İş Deneyimi, Durumluk-Sürekli Kaygı, Umutsuzluk*

ABSTRACT

In this paper it is aimed to measure the level of anxiety and hopelessness of graduate students and to find the relation with these factors and work experience in the labour market to find a job in the future. It is also tried to find the relation with work

[1] Bu makale 9-11 Aralık 2010 tarihlerinde Ankara'da düzenlenen Sosyal Hizmet Sempozyumu'nda sunulan bildirinin genişletilmiş ve gözden geçirilmiş halidir.