

LEGAL EDUCATION AND MATHEMATICS

Prof. Dr. Z. Gönül BALKIR
Dean of Law Faculty, Kocaeli University,
Department of Labor Law
Umuttepe, Kocaeli, TURKEY

Dr. Eylem APAYDIN
Kocaeli University, Faculty of Law
Umuttepe, Kocaeli, TURKEY

ABSTRACT

There is a natural integrity between law and mathematics arising from mathematics' being the primary device in the area of technical law even though the character of relationship between them is debatable. Instrumental use of mathematics is extremely important for technical aspect of law. Mathematical logic, statistics, probability logic, simulation models cannot be used in legal context without establishing the mathematics and mathematical relations.

While the legal system with mathematics aims to create or construct a more comprehensive and systematic world than a complex system or chaos; mathematics is the universe of the abstract and perfectly formed numerical collocations. In this context, law is the system of formed human relations, which is tried to be created by social mind.

The necessity of mathematical understanding in legal world, on one hand, proves how important mathematics is in legal education and on the other hand, it demonstrates how similarly both legal and mathematical systems are formed. Law and mathematics emerged as the formed result of humanity's search for perfection.

Key words: Law Mathematics Integrity, Use of Mathematics in Law, Legal Logic.

INTRODUCTION

The history of legal philosophy is packed with legal approaches such as legal rationalism, neo Kantianism, legal positivism, and normativist positivism and the discussions of these approaches' supporters, which try to explain legal science with the likeness of mathematics.

Legal science and education are directly related to mathematics and logic like all the other disciplines in social sciences. This study aims to demonstrate the relationship between law and mathematics and this relationship's contribution to law and especially legal education rather than the mathematical analysis of law.

MATHEMATICS AND LAW AS A BRANCH OF LOGIC

Mathematics and Mathematical Logic

Mathematics as a branch of logic consists of arithmetic, algebra and mathematical analysis. Mathematics composed of arithmetic, algebra and mathematical analysis uses all the concepts of logic. All theorems of mathematics can be inferred by the principles of logic by adding infinity and axiom of choice. In this context, it can be said that mathematical hypothesis are correct as the result definition of the terms mentioned in these hypothesis or that mathematical hypothesis make, the features attributed by the definition to the mathematical concepts, explicit. Undisputed correctness of mathematical hypothesis is the same with the certainty of such hypothesis like 'all singles are unmarried persons'. Mathematics scores a glaring success in factual world. Progress of science is a kind of progress depending that the obtained results build up reliable knowledge and mostly relying on its power to use and apply mathematical methods (Yıldırım, 1988).

Mathematics is an indispensable device to prove the validity of empirical knowledge and furthermore to express them. Most of the important theories in empirical sciences especially the ones having a great prevision and applicability, can be expressed by the assistance of the mathematical concepts. It is apparent that functional relations between numerical system and various metrics variables are used in the formulation of these theories.

The most distinctive feature which distinguishes mathematics from empirical sciences and makes it known as the queen of sciences is the certainty of mathematics and imperativeness of its results. There is no such certainty and imperativeness even in the most advanced ones of the empirical sciences. Accuracy of a hypothesis regarding an empiric fact can be highly probable at most according to its basis of evidences and it cannot be a certainty. A hypothesis in science cannot be free of possibility of getting disproved one day by new observations regardless how strongly it is proved. Hence, all scientific hypothesis and theories are of temporary character and are deemed as correct unless they conflict the facts. Whereas, a theorem in mathematics obtains certainty once it is proved and it cannot be disputed by any observation regardless however it conflicts (Yıldırım, 1988).

Mathematical Reasoning

Logic is crowned by mathematical reasoning. The core of mathematical reasoning is inductive and deductive reasoning. In mathematical reasoning, generality is the result of necessity. Generality is also the basic feature of deductive reasoning. Deductive reasoning is initially to see that a relation is essential and general. Inductive reasoning attempts to demonstrate the action and observation of the problem by a present relationship constant with a series of process relying on an empirical ascertainment (Cuvillier, 2003). It can be inferred from this conclusion that inductive reasoning is obligatory because coincidence and contingency cannot be assumed to form an absolute uniformity. Similarly, we necessarily use the word of induction as mathematical induction or complete induction in order to explain the mathematical reasoning even though it has been changed by a qualifier. Analogy, used widely in logic, is not reasoning but a part, or period, or annex of an induction (Cuvillier, 2003).

Mathematical induction is verification of a processing with feedback. In mathematical induction, initially, a theorem is formed for $n=1$, later if it is correct for $n-1$, it is proved that it is correct for n too and thus it is inferred that it is correct for all the whole numbers. Rule of reasoning with feedback cannot be reduced to the principle of paradox. This rule cannot be generated from the experiment. The conclusion that the experiment can teach us that the rule is correct for say the first ten, first hundred number; it cannot reach the infinite series of numbers but it can reach either the more or less but always a limited part of this series (Cuvillier, 2003). Hence, induction used in physical science is always uncertain as it relies on the general order of the universe, which is an external order for us (Cuvillier, 2003).

Mathematics as a Linguistic and Implication Device

Famous physicist W. Heitler examines the relationship between science and mathematics and says:

The more physics advances, the more it becomes abstract and hence the more it needs mathematics. At the level of abstraction in nuclear physics, it can be said that existence of an atom cannot be described as concrete in space but its abstractive existence is mathematically determinable...

Mathematics is not a natural science. We cannot identify the mathematical relations that we cannot find in nature with physical processes. At first sight, mathematics is a version of a pure invention of human mind like artistic works. Many branches of mathematics, when physics does not need them, were created by merely theoretical mathematicians, who were not interested in examination of the nature. What kind of relationship may mathematics, a product of our minds, have with nature and its laws? In this context, it should be regarded as a mind boggling miracle that that the outer world, which is independent from us, acts in compliance with the mathematical principles, which we solely create.

Nonetheless, it is not accurate that our mind and outer world are totally independent from each other, as generally assumed. One should remember that human mind is a product of the interaction which it has with the organism's environment and so it vaguely displays the environment's structural features. Therefore, it is not an unexpected that laws created in science and mathematics are compliant, even in different scales, with the basic character of the outer world. Indeed, it cannot be easily talked about the existence of a firm line of contrast between human and outer world. This contrast is not clear even at the simplest level of perception. The assertion cannot be acceptable that the mathematical objects and relations are only mental products, which are created by will. Doubtless, we owe the creation of these objects and relations to our mental activity. However, mind is not completely free in this creation. It is surrounded with some compulsoriness arising from outer world and subject's own necessities (Yıldırım, 1988).

It has been known that mathematic is an efficient expression device, an indispensable implication means, and a rich source of models for natural sciences so far since Galileo, even since Leonardo da Vinci, who said "a science is capable as much as it is mathematical"(Yıldırım, 1988).

The most distinctive function of mathematic in physics sciences is its being an appropriate device of language and expression. Mathematics as a language owes its efficiency to special symbols, and formulas and equations which turn natural laws into short, clear and certain explanations. Daily language, despite of its rich vocabulary and nuances, is away from the clear, obvious, and simple expression, which are sought in science. It also causes some kind of communication difficulties due to words' being vague or multi-meaningful. Whereas, mathematics, which may be deemed as an artificial language, provides a reliable expression and a convenient communication thanks to its use of symbols, whose meanings and areas of use are clear and limited.

Besides being a means of expression, mathematics is also important as an implication technique (Yıldırım, 1988). While attempting to explain the role mathematics in science, initially, the application power of differential equations stands out. Especially, the application emerged in physics by the use of these equations is truly astonishing. Indeed, it can be said that there is not any area of study which is not part of the application area of this technique, which constitutes the core of analysis

Mathematics also has a function to provide a model to sciences. Usability of a model is determined by its structural similarity by examined action or set of actions. Mathematical model's function is to express the set of objects or facts by equations and so to provide instruments for explanatory implications. Hence, any mathematical equation can be regarded as a model for another relationship as long as it is compatible. The same can be said for a proof or function. A model is valid as long as it serves its purpose of use. As the

compatible relationship can be mathematical, it may also belong to physical, biological, social or psychological facts world. (Yıldırım, 1988).

Relationship between Law and Mathematics

Understanding of the relationship between law and mathematics depends on the fact that both sciences' characters and features are comparatively known. While mathematics is science of the quantities as the science of numbers, law is, with its simplest appearance, a science related to norms and to technique of their applications (Can, 2005). Whilst law, by determining the allowed and prohibited acts, tries to reach the ideal with norms aiming to construct a design of social order, mathematics introduces a design of an abstract order with numbers. Mathematics creates an order consisting of abstract structures free from any embodiments. Both sciences aim and design an ideal order.

While concept of set, which provides the change from qualitative thinking to mathematical thinking, approximates mathematics to law, and directly relates to the technical aspect of law. Both law and mathematics use own peculiar languages. Mathematics is made up by a coded language with the symbols, which it uses. Similarly, law formed by a coded language with the qualitative content of the norms, which it introduces. While mathematical language is determined by its symbols, in other words, by the assistance of its form at its extension of abstraction, norm, which is only a meaning with its external appearance, reaches a complete concretion at the stage of enforcement (Can, 2005).

Independence of mathematics from human relations, as it only deals with `forms` by the means of symbols, can lead the decision makers in legal science to decide more fairly and guide them. Indeed, as mathematics is the extension of logic, or even logic itself, it can directly identify itself with law. Mathematical thinking is correct thinking. Mathematical thinking is achieved by mathematical understanding. Mathematical methods by abstracting the content focus the attention directly on "form". Correct thinking as a kind of mathematical thinking is essential in scientific areas like all areas of human life (Can, 2005).

It is essential to benefit from concepts and principles of logic and mathematics in law. Instrumental use of mathematics by law makes a significant contribution to technical law. Economic law, economics, statistics, informatics, probabilistic models, and simulation models are comprehended by mathematics. Similarly, mathematics models can be used to determine the frequency of a committed crime or to predict an outcome of a case. Since mathematics is quite functional in technical law, instrumental use of mathematics with objective structure provides instruments for an impartial justice and equality for legal practitioners.

Similarities and conceptual interactions between law and mathematics are incredible. Both sciences construct their systematic on logic, which is a subsection of mathematics. From a reductive point of view, it can almost be said that the core of law is mathematics. Indeed, the history of legal philosophy, as a consequence of this identity search, is filled with legal schools like legal rationalism, neo-Kantianism, legal positivism, and normative positivism and with conflicts and enhancements that they created.

Due to these interactions between law and mathematics, law was intended to be matched with mathematics by some theorists as the result of attempts to provide law with mathematical certainty and moreover, many theorists such as legal rationalists, neo-Kantianists, legal positivists, and normative positivists identified law with mathematics (Can, 2005).

Mathematics aims to create or construct a more comprehensive and systematic world than a complex system or chaos. Mathematics is the universe of the abstract and perfectly formed numerical collocations. In this context, law is the system of formed human relations, which is tried to be created by social mind. Law by establishing the order brings equality automatically. Legal system creates the equality by only considering the

outer appearances and differentiating the individual due to its formalism. As equality is the core of justice, it can be said that by basically establishing the order, law pretty provides the justice (Aral, 1987).

Objectivity and impartiality in law, which function in mathematics too, mean that a legal rule is directly applied to a specific case (Güriz, 2009). Our perception of justice and injustice and real cases lead us directly to the idea of equality, which is the visible element of justice.

The core of justice is the value of equality. The idea of equality forms the core and essence of justice. A case of natural equality is created by establishing the legal order. Order and equality have almost the same meaning in law. Indeed, regularizing the human relations is derived from the necessity of equality. As known, to regulate in law means 'to form'. On the other hand, to form is to deal with only the common aspects excluding the differing features. Hence, by excluding the individualities, only equality exists. This equality is almost the natural result of the regulating function of legal norms. There is no need for a specific equality principle and concern for this. As the result of regulating function, legal norms equalize all the relations and situation, which they are set forth. Equality exists in the character of law and indeed it determines the character of law. Therefore, equality before the law as a type of equality exists in every legal system (Aral, 1987).

MATHEMATICS IN LAW AND LEGAL EDUCATION

Methodology in Law and Legal Education

Legal methodology, besides explaining the legal norms and, are the methods, which also get them to be evaluated objectively and aim to provide solutions to the problem of being fair (Güriz, 2003a).

Positive law as the application of rules is the law, which is in force in a certain society and in a certain period and can be amended in time. What law is going to be is decided by its creators and they amend it when necessary (Aral, 2001). Positive law as the applied law serves the purpose of identification of the will of law makers, which becomes apparent in Acts (Güriz, 2003b).

It is necessary to pass the idea of abstract justice to the idea of concrete justice and behavioral methods in order to evaluate the norm carriers and norm ideas in law. When examining the relationships between order, idea, and justice, the problem how to realize the upper justice principle and rule of law arises. In this context, it is essential to re-plan the arguments. Legal methodology can be regarded as a device in a changing environment.

While tending to the concrete in the way of becoming a science, law, besides only rational implications and indications, prefers using induction and deduction and sensing the individual cases from a general appearance (Timuçin, 2003). The conditions, which makes securely, freely and responsibly working possible for legal jurists in the process of producing of science, should be prepared as a systematic of rights (Ökçesiz, 2006).

Social reality accepted as a source of law, is objective and a significant part of existence. Law is a concept that law makers, indeed holders of power, call compulsory and is a product of their discretionary wills. In modern world, law can only be described literally as an order and arrangement, which is burdened to serve to justice. On the other hand, justice is an objective value settled in the humans' hearts (Aral, 2003).

It is the responsible of legal science to determine whether the social phenomena and actions, which are the theme of legal problems, are originally and bodily subject to reliable and unchangeable natural law, if they are, to establish which methods and mechanisms would be used to resolve the social phenomena and actions universally and constantly. Establishing law on the scientific basis depends on humans' nature or objects' nature or maybe, more truly expressed, it depends on the synthesis containing the integrity with social

humans' universal nature. Furthermore, legal legitimacy should be sought in these grounds and synthesis. (Öktem, 2005).

Social sciences host various disciplines such as economics, sociology, anthropology, social psychology, law, and ethics, whose study areas are different. Each scientific discipline chooses applicable methods in accordance with its own study area and hence it differs from the others. If it is accepted that the empirical method is one of the most important methods in social science, economics is the most successful one in using the empirical methods among the others. Compatibility of economics to be digitalized is the basic indication for this (Işıқтаç-Metin, 2003).

The subject of logic and mathematics, which are concreted by the mere expression of concepts, take place among the ideal subjects. On the other hand, subjects of real sciences exist depending on their relationship with causality and time as they are eligible to be perceived by internal and external sensations. Sociology and natural sciences such as physics, chemistry, and biology are the primary example of real sciences. Ideal sciences deal with ideal subjects and real sciences deal with real subjects.

The rules of rationalism, which are not located in time and place, non-perceived, and abstract, can remove the possibility of their being used in real areas too. To sum up, mind, which is the instrument to reach the absolute result in ideal sciences, has to give ground for experiment or maybe more accurately, it has to be complemented by experiment. Different sources of knowledge in ideal and real sciences differentiate the methods used by ideal and real sciences too.

The criterion determining the content and limits of scientific method is its verifiability by facts. As qualifying features, science is factual, logical, objective, critical, generalizing, and elective (Işıқтаç, 2006). As a known thing, reality exists individually and independently from human mind. Another perception of objectivity, origins from the elimination of subjective elements, blurs our mental perception (Fay, 1996).

Mathematics in Legal Education

In social sciences, rules of deduction method are applied to real incidents. In social sciences, social structures' and societies' and nations' history or their current situations are examined in by the assistance of other disciplines and common general rules are inferred (Öktem, 1985). On the other hand, law by the means of norms affects humans' free zone and law by the means of commanding proposition norms demonstrating how human behaviors should be, demands the individuals to adopt a certain type of behaviors. The structure of law and legal norm form the focus of some epistemological debates (Keyman, 2003).

Is the certainty in legal propositions a mathematical certainty? On the other hand in practice, is a complete certainty achievable in advanced mathematics? While rationalist natural lawyers, as they admire the mind's power, try to provide law with mathematical certainty and try to adopt the universal mathematics approach in law, they have to be careful that these two sciences' subjects and targets are different.

Although it is not possible to transform law into mathematics in real, as logic and mathematical logic embrace processes such as forming concept, setting a proposition, and making implications, and principles such as identicalness, no contradiction, the third possibility not, law inevitably uses mathematical analysis (Can, 2005). On the other hand, any social order rule cannot be created by analogies set by mathematical realities and by application of a so-called deduction without the considering the social conditions determining the factual (2005).

As a specific type of social cases, legal case has been struggling with many difficulties even though it is evaluated by legal sociology and empirical approach. Besides law being multi-sourced, different legal disciplines such as current positive law, law of custom and tradition, international law, and law of communities affect

decision makers' objective judgment and create chaos. An unbiased and fair decision requires objectively examining of all sources in this area. There is always a nuance between what law makers recognize as law and what the addressee' understand from law. That legal applications are not successfully subjected to statistics evaluation, and in addition, that the most basic legal research has not been completed in our country, drift the researchers in this area into the unknown (Işıktaç & Metin, 2003).

The abundance of variables in legal cases requires a strong legal logic and mathematical legal method for decision makers and legal practitioners. The problem of multi-variables and difficulty to make experiments in social sciences necessitates the use of legal logic and mathematics. The difficulty to access to information in social sciences and the problems about evaluation process can only be resolved by the principles and methods of mathematical logic. On the other hand, evaluation process stating the technical aspect of scientific research and resolving the security problem requires both objectivity and impartiality (Işıktaç & Metin, 2003).

Success of legal education in evaluation demonstrates the quality of the education and scientific research. Indeed, it is observed that some social sciences are luckier and more successful in evaluation. Use of statistics is highly dense in economics and politics and in fact it has become an indispensable method. The big problematic researches like system studies can become evaluable by statistical data. Statistics generally is used in law at the stage of making legal amendments in order to observe the result of previous applications. Statistical assessment is also possible in the evaluation of High Courts' Decisions and in the determination of the judges' behavior and their tendencies. It is necessary to say that works of Institute of Statistics in Turkey are used in some legal research as a general evaluation criterion (Işıktaç & Metin, 2003).

Mathematical Analysis of Law: a New Research Method

Deterministic rules are valid in law too. In law, it is tried to be determined certainly what is going to be classified as a crime and what is not. On the other hand, life and social incidents are based on complexity and uncertainty. It is almost impossible to reach the objective truth with given legal rules by interpreting a case from this complexity and uncertainty. One of the most difficult aspects of the legal education is to teach the students to take right and fair decisions in these ambiguities. Aristotle's' logic, which relies on one single truth, is unsatisfactory in understanding and analysis of legal realities, which rely on multi-values and multi-value judgments. Moreover, rather being unsatisfactory, this logic confuses the legal justice and leads to unfair and unequal consequences.

A more objective research method is required to assess ambiguities and complexities more efficiently and healthy. The principles and rules of mathematical logic and mathematical analysis of law can be used as a modern method for especially young lawyers and law students and those who are responsible for taking decisions in legal decision mechanisms to decide less risky and more confidently.

How is the equality in determination of the responsibilities of the multi-persons, multi-incidents and multi-realities will be provided in deciding aggravating circumstances and extenuating circumstances about incidents and intents while trying to establish justice and rule of law since it is obligatory to decide in accordance with the current law. A balanced and fair final decision can be taken and equality and justice can be provided as long as it is decided by considering these aggravating and extenuating circumstances and factors.

Rules of mathematical logic can be used in the interpretation of complex and multi-realities and in the applied comparison of scientific values. It is possible to take a fairer and more egalitarian decision in legal proceedings by rules and methods of mathematical logic. Instrumental use of methods of mathematical analysis and logic can provide a more true and realistic interpretation of human behaviors and processes in the complex perception and interpretation of legal realities.

Insufficiency and imperfection of lawyers' mathematical perception directly affect the concept of equality, justice and impartiality in law. Lawyers in legal process generally need mathematical analysis of law about the subjects related to logic and economics. Legal rules can be interpreted more truly and fairly by analytical logic of mathematical analysis. The applicable mathematical principles and methods in mathematical analysis of law establish the ground for realization of justice and equality values.

CONCLUSION

A legal practitioner in legal practice comes across many mathematical concepts with a glance for the search of a mathematical device. The eye coincides with the principle of equality first, and then, with the link of causality attached to the principle of equality. Without the link of causality, cause and result relation cannot be detected and legal system cannot be set. On the other hand, principle of equity as the core of individual law is the direct version of equality given to individuals. The eye, if it goes a little further, will find the network of mathematical relations of economic law.

Where one aspect of mathematical law relies on the four arithmetical operations and statistics, the other aspect especially in alternative claim and legal action forms of law requires a direct mathematical logic and view.

Decision processes and decisions taken by legal practitioners and decision-makers cannot be truly applied without equations for multiple unknown and a strong understanding and perception related to these equations.

It is essential to examine the relationship between law and mathematics to comprehend the role of mathematics in legal education. The concept of equality, which is the hearth of justice, and legal thought and legal system based on justice and equality, directly rely on mathematical thoughts and logic.

The responsibility of mathematical understanding in law proves how essential mathematics is in legal education and furthermore it also demonstrates that legal and mathematical systems are created similarly. Law and mathematics have accrued as a fictional consequence of human beings' search for perfection.

Methods used by law in mathematical analysis form a basis for legal proceedings and equity. Law's dependence on mathematics inevitably creates a unity of law and mathematics and an integrated structure including equality, generality, objectivity, and impartiality, which are common to both disciplines, in order to establish the justice. This relationship between law and mathematics requires them to act together in joint processes and application.

Integrity of law and mathematics and its complex and compelling character arisen from the dependence of law on mathematics legitimate the relationship between law and mathematics. However this relationship is controversial, there is an organic integrity between law and mathematics as mathematics is the most primary instrument in technical law. Instrumental use of mathematics is indispensably important for the technical aspect of law. In law, mathematical logic, statistics, probability logic, and simulation models cannot be applied without using the principles of mathematics and mathematical logic.

BIODATA AND CONTACT ADDRESSES OF AUTHORS



Zehra Gönül BALKIR was born in Istanbul in 1956. After leaving İzmit High School, she graduated from the Istanbul University Faculty of Law in 1978. While she was working as an attorney at law between 1979 and 1994, she continued firstly her master studies between 1983 and 1985 and then her PhD studies at the University of Istanbul between 1986 and 1989.

Having participated in the foundation of University of Kocaeli as a founder member with the title of assistant professor, she moved to the academic life in 1994. While she was acting as the Deputy Dean between 1994 and 2000, she gained title of Doçent (Associate Professor) in the area of Labour Law and Social Security Law in 2000. She worked as the director of University of Kocaeli Kandıra Vocational High School between 2001 and 2006. She was appointed as professor of Labour Law and Social Security Law and dean of Faculty of Law in 2006. She is still at these positions.

Researching on Labour Law and Social Security Law, Law of Earthquake, Law of Architecture, Women's Rights and Women Labour Law, and Legal Philosophy, Z. Gönül Balkır has published books named as "Disables' Participation in Working Life", "Social Rights in Constitutional Procedures", "Architectural Labour Law", "Development of Non-Governmental Organizations". Besides, she has made numerous presentations in national and international conferences, and has published many articles in local and national journals.

Prof. Dr. Z. Gönül BALKIR
Dean of Law Faculty,
Department of Labor Law
Kocaeli University,
Umuttepe, Kocaeli, TURKEY
Tel: 0 532 324 89 00
E. Mail: gonulbalkir@yahoo.com



Dr. Eylem APAYDIN, who was born in Kirşehir in 1979, left Kırıkkale Anatolia Teacher High School in 1996 and graduated from University of Ankara Faculty of Law in 2000. He completed his legal practice training in Ankara Bar Association in 2001. While he was working as a Candidate Judge in Ankara Courts, he went to the UK for higher education purposes thanks to his scholarship granted by the Ministry of National Education.

He was granted his LLM degree from the University of Kent in 2004 and his PhD award from the University of Leicester in 2010.

Dr. Eylem Apaydın has been working as a researcher at the Department of Civil Law at the University of Kocaeli Faculty of Law. Dr. Apaydın, maintaining his research on all areas of civil law, is expert on International Contract Law, Co-ownership and Trust Law.

Dr. Apaydın's book is being prepared to be published soon in the UK.

Res. Assist. Dr. Eylem APAYDIN
Kocaeli University, Faculty of Law
Umuttepe, Kocaeli, TURKEY
Tel: 05077468810
E. Mail: eyapaydin@yahoo.com

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