Recent Trends in Mathematics and Potential Contribution to other Disciplines

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ABSTRACT
The intention of this paper is to study the recent trends in present-day mathematics and role of mathematics in other disciplines. The paper is in five parts. Section one is Introduction. Section two is dealing with trends of application areas of mathematics at the wake of the twentieth century, Section three looks at the changes in mathematics application as a result of the modern approach to mathematics and discoveries in other fields, section four addresses the current thinking of collaborative and inter discipline mathematics and the section five gives some examples of application areas where mathematics is emerging as a vital component with great opportunities for inter discipline research.

Keywords- Trend in Mathematics, Mathematical research activity, Inter-discipline mathematics, new areas of application.

I INTRODUCTION

Math is present in day to day life and is being used even when people don't realize they are using mathematical reasoning. Everyone calculates time schedules, budgets, discounts and even gratuities. Understanding the basics of math helps people operate in a work setting too. This is true whether you are an hourly laborer or have a career in the medical field. Math is part of your daily routine. Almost all areas of human activity make more and more use of mathematics. They use all branches of mathematics, not just traditional applied mathematics. Mathematical activity like research, applications, education, exposition, has changed a lot in the last some years. Some of these changes, like the use of computers, are very perceptible and they are being applied in mathematical education fairly broadly. Many new forms of mathematical activity like algorithms and programming, modelling, conjecturing, expository writing and lecturing, are acquisition significance. I will say some more about the new trends in mathematics, and discuss the question of their influence on mathematical education.

(a) Trends of 20th century-The 20th century made a rethink on the foundations of mathematics, it was marked out by a new approach to mathematics. In International Congress of Mathematicians, David Hilbert's (1862-1943) vision was to analyses axioms of each subject and state results in their full generality. This vision became concrete in the 1930's through the development of the axiomatic approach to algebra. Parallel trends took place in functional analysis with Banach Spaces. This extent to other subfields of mathematics like partial differential equations, harmonic analysis and algebraic topology.

The 20th Century continued the trend for increasing generalization and abstraction in mathematics, in which the notion of axioms as “self-evident truths” was largely discarded in favour of an emphasis on such logical concepts as consistency and completeness. This century approach to mathematics resulted in a more developed mathematical language, new powerful mathematical tools, and inspired new application areas that have resulted in remarkable discoveries in other applied sciences. Towards the end of the 20th Century, mathematicians were making a re-think on the need to bridge the division lines within mathematics, to open up more for other disciplines and to support the line of inter-discipline research. The current cry is that this interaction will be further stabilized in the 21st Century. In the drive to seek generality, 20th century mathematics became more diverse, more structured and more complex.

(b) Trends in mathematics today-In this section, I will discuss broad trends in mathematics today. These are as follows:

(i) Variety of applications- The increased variety of application shows itself in two ways. On the one hand, areas of science have become "infected". This is clearly true of the social sciences, but is also a feature of present-day theoretical biology. Another contributing factor to the increased variety of applications is that areas of mathematics, so far regarded as impregnable pure, are now being applied. Algebraic geometry is being applied to control theory and the study of large-scale systems; combinatory and graph theory are applied to economics; the theory of fibber bundles is applied to physics; algebraic invariant theory is applied to the study of error-correcting codes. Thus the distinction between pure and applied mathematics is seen now not to be based on content but on the attitude and motivation of the mathematician. I would go further and argue that there should not be a sharp distinction between the methods of pure and applied mathematics. Certainly such a distinction should not consist of a greater attention to rigidity in the pure community, for the applied mathematician needs to understand very well the domain of validity of the methods being employed, and to be able to analyses how stable the results are and the extent to which the methods may be modified to suit new situations. An impartial distinction between "pure" and "applied" mathematics, would seem to be one between "inapplicable" and "applicable" mathematics. We wish to study a "real world" problem; we form a scientific model of the problem and then construct a mathematical model to reason about the scientific or conceptual model. First, the concept of applicable mathematics needs to be broad enough to include parts of mathematics applicable to some area of mathematics which has already been applied; and, second, that the methods of pure and applied mathematics have much more in common than would be supposed by anyone listening to some of their more vociferous advocates. For our purposes now, the modules for mathematics education to be drawn from looking at this trend in mathematics are twofold; first, the distinction between pure and applied mathematics should not be emphasized in the teaching of mathematics, and, second, opportunities to present applications should be taken wherever appropriate within the mathematics curriculum.

(ii) New unification of Mathematics-Before a decade, the most characteristic feature was the vertical development of autonomous disciplines, some of which were of very recent origin. Thus the community of mathematicians was partitioned into sub communities united by a common and rather exclusive interest in a fairly narrow area of mathematics (algebraic geometry, algebraic topology, homological algebra, commutative ring theory, real analysis, complex analysis, set theory, etc.). Indeed, some would argue that no real community of mathematicians existed, since specialists in distinct fields were hardly able to communicate with each other. I do not impose any blame to the system which prevailed in this period. Indeed, it was historically inevitable but it does appear that these autonomous disciplines are now being linked together in such a way that mathematics is being reunified. I believe that the appropriate education of a contemporary mathematician must be broad. The lesson to be drawn from the trend toward a new unification of mathematics must involve a similar principle. We must break down artificial barriers between mathematical topics throughout the student's mathematical education.

(iii) The universal presence of the computer-The third trend to which I have drawn attention is that of the general availability of the computer and its role in actually changing the face of mathematics. The computer plays an entirely constructive role in our lives and in the evolution of our mathematics. The computer is changing mathematics by bringing certain topics into greater prominence - it is even causing mathematicians to create new areas of mathematics, for examples, theory of computational complexity, the theory of automata, mathematical cryptology etc. At the same time it is relieving us of certain tedious aspects of traditional mathematical activity which it executes faster and more accurately than we can. It makes it possible rapidly and painlessly to carry out numerical work, so that we may accompany our analysis of a given problem with the actual calculation of numerical examples. On the other hand, the computer renders obsolete certain mathematical techniques which have been prominent in the curriculum still now.

II INTER-DISCIPLINE MATHEMATICS AND POTENTIAL CONTRIBUTION TO OTHER FIELDS

Currently, efforts are being undertaken to facilitate collaborative research across traditional academic fields and to help train a new generation of interdisciplinary mathematicians and scientists. Disciplines that hardly used mathematics in their curricula are now demanding substantial doses of knowledge and skills in mathematics. For example, Curricula for the social sciences programmers now include sophisticated mathematics over and above the traditional descriptive statistics. Curricula of some

(a) Teaching Strategies*:* An integrated approach to the curriculum., stressing the Interdependence of the various parts of mathematics.

(i) Simple application.
(ii) Historical references.
(iii) Flexibility.
(iv) Exploitation of computing availability.

(b) Topics*:* Geometry and algebra Probability and statistics.

- Approximation and estimation, scientific notation.
- Iterative procedures, successive approximation.
- Rational numbers, ratios and rates. Elementary number theory.

(c) Paradoxes.

(i) Teaching Strategies

- Authoritarianism.
- Orthodoxy.
- Pointlessness.
- Pie-in-the-sky motivation.

(ii) Topics

- Tedious hand calculations.
- Complicated trigonometry.
- Learning geometrical proofs.
- Artificial "simplifications".
- Logarithms as calculating devices.

universities in the developed countries have inter disciplinary programmers where mathematics students and students from other sciences work jointly on projects. The aim is to prepare graduates for the new approaches and practices in their fields and careers.

As evidenced by the discoveries of the last half of the 20th century, mathematics can enrich not only physics and the other discipline of sciences, but also medicine and the biomedical sciences and engineering. It can also play a role in such practical matters as how to speed the flow of traffic on the Internet or sharpen the transmission of digitised images, how to better understand and possibly predict patterns in the stock market and even how to enrich the entertainment world through contributions to digital technology. Through mathematical modelling, numerical experiments, analytical studies and other mathematical techniques, mathematics can make huge contributions to many fields. Mathematics has to do with human genes, the world of finance and geometric motions. For example, science now has a huge body of genetic information, and researchers need mathematical methods and algorithms to search the data as well as clustering methods and computer models to interpret the data. Finance is very mathematical; it has to do with derivatives, risk management, portfolio management and stock options. All these are modeled mathematically, and consequently mathematicians are having a real impact on how those businesses are evolving. Motion driven by the geometry of interfaces is omnipresent in many areas of science from growing crystals for manufacturing semiconductors to tracking tumors in biomedical images. The convergence of mathematics and the life sciences, which was not foreseen a generation ago, is a remarkable opportunity for application.

(d) Interdisciplinary Areas

Research areas are many and exciting. They include:

(i) Mathematics for materials
(ii) Security issues (mathematics for Information and Communication, Mathematics for sensors, mobile communication as well as network security and protection)
(iii) Demands in software reliability where mathematics is needed for computer language, architecture, etc.
(iv) Requirements for automated decision making (probability, stochastic analysis, mathematics of sensing, pattern analysis, and spectral analysis) and
(v) Future systems (lighter vehicles, smaller satellites, ICBM Interceptors, Hit before being Hit, secured wireless communication systems, super-efficient energy/ power sources, modeling and simulations, robotics and automation.

III FIELDS WHERE MATHEMATICS IS EMERGING VITAL

During the last 50 years, developments in mathematics, in computing and communication technologies have made it possible for most of the breath taking discoveries in basic sciences, for the remarkable innovations and inventions in engineering sciences and technology and for the great achievements and breakthroughs in economics and life sciences. These have led to the emergency of many new areas of mathematics and enabled areas that were inactive to explode.

The examples are from the disciplines of materials sciences, study of composites, digital technology and health care field. Below are summaries of the examples:

(a) Mathematics in Materials Sciences-

Materials sciences is concerned with the synthesis and manufacture of new materials, the modification of materials, the understanding and prediction of material properties, and the evolution and control of these properties over a time period. Until recently, materials science was primarily an empirical study in metallurgy, ceramics, and plastics. Today it is a vast growing body of knowledge based on physical sciences, engineering, and mathematics. For example, mathematical models are emerging quite reliable in the synthesis and manufacture of polymers. Some of these models are based on statistics or statistical mechanics and others are based on a diffusion equation in finite or infinite dimensional spaces. Simpler but more phenomenological models of polymers are based on Continuum Mechanics with added terms to account for 'memory.' Stability and singularity of solutions are important issues for materials scientists.

(b) Study of composites-Motor companies are working with composites of aluminum and silicon-carbon grains, which provide lightweight alternative to steel. Fluid with magnetic particles or electrically charged particles will enhance the effects of brake fluid and shock absorbers in the car. Over the last decade, mathematicians have developed new tools in functional analysis, PDE, and numerical analysis, by which they have been able to estimate or compute the effective properties of composites. But the list of new composites is ever increasing and new materials are constantly being developed. These will continue to need mathematical input

(c) Mathematics in Digital Technology- The mathematics of multimedia encompasses a wide range of research areas, which include computer vision, image processing, speech recognition and language understanding, computer aided design, and new modes of networking. The mathematical tools in multimedia may include stochastic processes, Markov fields, statistical patterns, decision theory, PDE, numerical analysis, graph theory, graphic algorithms, image analysis and wavelets, and many others. Computer aided design is becoming a powerful tool in many industries. This technology is a potential area for research mathematicians. The future of the World Wide Web will depend on the development of many new mathematical ideas and algorithms, and mathematicians will have to develop ever more secure cryptographic schemes and thus new developments from number theory, discrete mathematics, algebraic geometry, and dynamical systems, as well as other fields.

(d) Mathematics in Health Care Field-A doctor, nurse, X-ray technician, pharmacist and all others in the health care field must have the knowledge of mathematics. A physician must understand the dynamics of the human body to diagnose illness and administer medication. Many prescriptions require the use of a formula based on the weight of a patient to determine the proper dosage. When a doctor writes a prescription out to the pharmacist, he must be able to calculate the amount of medication received with each treatment.

There are other uses of math in the life of a doctor. For example, various lab tests report results in a numerical format. A CBC is a standard test preformed to measure levels of blood cells. The technician draws blood, the lab performs the analysis and reports that information to the doctor. The physician must understand percentages and ratios of different cells for his patient. He must know the normal parameters in order to establish an abnormal test result. Based on his ability to make a precise determination, he may know how to treat the patient.

Nurses not only care for a patient, they must also take readings and perform calculations. The old-school method of reading a pulse requires touching the radial pulse and counting the number of beats for a few seconds. A nurse must then calculate the heart beat per minute based on that number. Determining appropriate IV drip requires a calculation to dispense intravenous fluid for an accurate rate flow, such as 10drops/ml. A patient's chart records many factors in a numerical state. The amount of urine out is a measurement; the oxygen level in the blood stream is a ratio or percentage. Understanding basic math and algebra is a vital tool for nurses. Whether the nurse is charting notes or administering treatment, math is a crucial component.

A pharmacist does much more than dispense medication. In many ways, the pharmacist is a checkpoint for the math of a prescribing agent, such as a doctor or physician's assistant. Since so many dosages are mathematical formulas, a pharmacist must double-check the assessment made to determine the dosage. The American Pharmacists Association reports one essential prerequisite for a career in pharmacology is a strong education in math and science. A pharmacist will sometimes mix IV medications in a hospital setting. This requires the ability to understand how much saline is required to be unit of medicine. Math is certainly a large part of a pharmacy. Pills must be counted, formulas must be calculated, all math functions that require proper administration by a pharmacist.

Now every branch of mathematics has a potential for applicability in other fields of mathematics and other disciplines. All these, have posed a big challenge on the mathematics curricula at all levels of the education systems, teacher preparation and pedagogy. The 21st Century mathematics thinking is to further strengthen efforts to bridge the division lines within mathematics, to open up more for other disciplines and to foster the line of inter-discipline research.

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