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Why Study Mathematics? Applications of Mathematics in Our Daily Life

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Abstract: Mathematics plays a predominant role in our everyday life and has become an indispensable factor for the progress of our present day world. Counting starts from day one of the birth of a person. Most students would like to know why they have to study various mathematical concepts. Teachers usually cannot think of a real-life application for most topics or the examples that they have are beyond the level of most students. Mathematics is generally regarded as the driest subject at school, made up of routine, difficult, boring, arcane and irrelevant calculations which have nothing to do with discovery and imagination. In this paper, I have discussed the purposes of mathematics, aims of mathematics education and the rationales for a broad-based school curriculum followed by some examples of applications of mathematics in the workplace that secondary school and junior college students can understand. Lastly, I will look at how mathematical processes, such as problem solving, investigation, and analytical and critical thinking, are important in the workplace. The truly outstanding work of this research paper is a collection of review papers / articles investigating the open problems. In this paper I have discussed recent advances, problems and their current status as well as historical background of the subjects. It will help the students in pursuing higher education in their respective fields.

INTRODUCTION

When teachers try to convince their students that mathematics is useful in many professions, such as engineering and medical sciences, many of their students may not be interested in these occupations. For example, when some of students wanted to be computer game designers instead, but they wrongly believed that this profession did not require much mathematics, so they need to be demonstrated that computer programming required some mathematics did they show any interest in studying mathematics. In today world the use of mathematics is not limited up to just pass the paper, it is widely used in games for example cricket, football and many other games like soccer players, they did not realize that the sport could involve some mathematics: they erroneously thought that they would have to kick the ball high enough to clear it as far away as possible; obviously, it could not be at an angle of 90° from the ground but they believed it to be about 60° when in fact it should be 45°. Although this is a concept in physics, kinematics is also a branch of mathematics, not to mention

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that “mathematics is the queen of the sciences” (Reimer & Reimer, 1992) − a famous quotation by the great mathematician Carl Gauss (1777-1855). Mathematics can also help soccer players to make a more informed decision if they know which position on the soccer field will give them the widest angle to shoot the ball between the goalposts. However, there are still many jobs that may not require much mathematics, except perhaps for simple arithmetic like counting money and telling time, e.g., actors and actresses, taxi drivers, administrators, historians and language teachers. How often do they use, for example, algebra, in their workplace? Why study so much mathematics when many adults do not even use it in their professions? Isn’t it a waste of time and resources? I will address these issues by first examining the purposes of mathematics and the aims of mathematics education. Then I will discuss the rationales for a broad-based school curriculum which pertains not only to the learning of mathematics specifically but also the study of other subjects in general. After that, I will focus on real-life applications of mathematics in the workplace by giving suitable examples that secondary school and junior college students can understand. But mathematics involves not just concepts and procedural skills but also thinking processes. Therefore, I will discuss how mathematical cognitive and met cognitive processes, such as investigation proficiency, problem solving strategies, communication skills, and critical and creative thinking, are important in and outside the workplace in our daily life. The 21st century is the age of knowledge-based economy, and the center-stage of change. Higher education has not escaped the impact and is in the process of challenge, thereby challenging the traditional system of education. The disparity in wealth and quality of life between the developed and developing world has been attracting the attention of the world. The exponential growth of population in the developing countries is matched by the exponential growth of knowledge in the developed world. All developing countries the efforts are being made by the respective Government to promote higher education. Central Government and state Governments are trying to nurture talent through focusing on the number of Universities and Colleges for expansion of higher educations. In the Year 1950-51, there were 30 universities and 695 colleges. This number has increased to 634 Universities and 33023 colleges’ up to December 2011. The following table reveals the growth of higher education in India. In the table 1 the number of institutions related to higher education upto 2011-12 is shown. It indicates that there is expansion of high education In India. The Central and state Government have taken initiatives to promote higher education. In the year 2011-12, the number of Universities and Colleges was 690 and 35539 respectively in India.

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Table 1: **Number, Nature and Category of Institutions (2011-12)**

S.No.	Types of institution	Numbers
1	Central Universities	44
2	State Universities	306
3	State private Universities	145
4	Deemed Universities	130
5	Institutions of national Importance plus other institutions	60
6	Institutions established under state legislative acts	5
	Total	690
7	Total Colleges	35,539
	Grand Total	36,229

Source: Economic Survey of India, Ministry of Finance, New Delhi.

The higher education sector has undergone major changes throughout the world which led to increased competition for institutions in this sector. According to UNESCO, "higher education is no longer a luxury; it is essential to national, social and economic development". The quest to achieve Education for All (EFA) is fundamentally about assuring that children, youth and adults gain the knowledge and skills they need to better their lives and to play a role in building more peaceful and equitable societies. This is why focusing on quality is an imperative for achieving EFA. As many societies strive to universalize basic education, they face the momentous challenge of providing conditions where genuine learning can take place for each and every learner. Quality must be seen in light of how societies define the purpose of education (EFA Global Monitoring Report, 2005). Quality improves the value of education. So there is a lot of importance nowadays to increase the value of education. Pupil/teacher ratios remain higher than is desirable in many countries of sub-Saharan Africa (regional median: 44:1) and South and West Asia (40:1). In many low-income countries, teachers do not meet even the minimum standards for entry into teaching and many have not fully mastered the curriculum. The HIV/AIDS pandemic is severely undermining the provision of good education and contributing significantly to teacher absenteeism. This results in improvement of the value of education. The central planks of most education systems are expected to ensure that all pupils acquire the knowledge, skills and values necessary for the exercise of responsible citizenship.

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The broad objective of education is to create a sizeable population of such educated men and women who could understand the world well enough and are able to bring about a change leading to adequate health and education services, a better environment, and elimination of ignorance and deprivation (limitations), which continue to strangulate the developing societies. The policy, therefore adhering to the principles of equity, quality and efficiency place added emphasis on the education of the people, who are under-privileged and live in misery.

In the next few decades, India will probably have the world's largest set of young people. Even as other countries begin to age, India will remain a country of young people. If the proportion of working population to total population increases, that should be reflected in a sharp increase in the country's savings rate. And if India can find productive job opportunities for working population, that would give India a big opportunity to leapfrog in the race for social and economic development and as a result growth rates would go up. China and other countries of South East Asia face the phenomenon of ageing population and India is an exception to this rule. Therefore, it might be India's opportunity to leapfrog in the race for social and economic development. India's youth can be an asset only if there is an investment in their capabilities. A knowledge-driven generation will be an asset. If denied this investment, it will become a social and economic liability must be able to attract global investment into R&D activity at home and should put in place the required legal and physical infrastructure that can attract more foreign investment in R&D activity.

The National Knowledge Commission's (NKC) recommendations have been crafted to achieve the objective of tapping into India's enormous reservoir of knowledge, to mobilise national talent and create an empowered generation with access to tremendous possibilities. With 550 million below the age of 25, India's demographic dividend is a greatest asset. By recommending reforms in the education and associated sectors, NKC aim has been to provide a platform to harness this human capital, which has the ability to change the course of development in the country. Recommendations have also been suggested in other key areas, because to adequately tap this potential, the right development paradigm has to be created by investing in intellectual capital, developing the skill set of the population, strengthening research, encouraging innovation and entrepreneurship and creating effective systems of e-governance.

Objectives of the Study

- To analyse the Purpose and Aims of Mathematics.
- To know the need for popularization of Mathematics.
- To analyse applications of Mathematical knowledge in the workplace.

Research Methodology

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The study is explorative cum descriptive in nature. It is an empirical research based upon secondary data. The theory is basically developed from secondary sources of information and a thorough study of various academic works in the relevant field has been attempted.

Purposes and Aims of Mathematics

Mathematics is generally regarded as the most dry subject at school, made up of routine, boring, arcane and irrelevant calculation which have nothing to do with discovery and imagination. You may have noticed how terms in mathematics have an unnerving effect on most students as well as the public. “Dull” and “Urgh” are the most common epithets often used to describe the subject. Whether we realize it or not, mathematics is around us, in our everyday life, and we are using the subject. Mathematics exists in nature. Mathematics is used in the kitchen; when we prepare our food, we must put in enough amounts of salt and spices in the curry, otherwise it will be too hot, tasteless, or very salty. To build a house we need mathematics for its shapes and to estimate the cost needed. We need mathematics when we go shopping, and when we are on the highway. Even then, whenever we talk about mathematics, many fear the subject; they have the mathematic phobia, and try to avoid it. The fact is that, mathematics forms part of our life. We have to make the public aware of this. This is the duty of mathematicians or mathematical scientists. Popularization of mathematics could be done at various levels in the society, at home, nurseries, schools, universities, offices, supermarkets, highways and elsewhere. In this paper we will discuss how this could be achieved. The role of mathematics in society is subtle and not generally recognized in the needs of people in everyday life and most often it remains totally hidden in scientific and technological advancements. The old saying: “The one who lives hidden lives best” is not true in present day society. If a subject becomes invisible, it may soon be forgotten and eventually it may even disappear. Mathematics has such a prominent place in school curricula all over the world that probably nobody can imagine such a fate for this subject. But if we do not constantly care about the image of mathematics, we will see continuing pressure to lower the amount of mathematics at primary schools, secondary schools and at the university level. Mathematics is exciting to many people but at the same time is considered difficult and somewhat inaccessible by many more. Since mathematics is the fundamental cornerstone in many diverse areas of society, it is important for civilization as a whole that mathematicians do their utmost to help explaining and clarifying the role of mathematics.”

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Mathematics in Nature:

Mathematics exists in nature. The mathematical element, symmetry, exists in natural objects such as snowflakes, honeycombs, insects, leaves, flowers, butterflies, fish, crabs, and starfish (Figure 1), and also in man-made objects such as carvings on wood or ceramics, woven straw for food cover (Figure 2) and motifs in songket weaving (Figure 3).

a. Butterfly

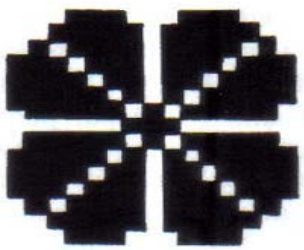
b. Leaves

c. Sea coconut

Figure 1: Natural symmetry

Figure 2: Woven straw for food cover

a. Pucuk Rebung (Mangosteen Stalk)



b. Tampuk Manggisnbn (bamboo Shoot)

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Figure 3: Motifs in songket weaving

Multiplication Table and Mathematical Songs

A multiplication table is easily memorised if it is sung. During our time, primary school children read or memorised multiplication tables (in the Malay language) by singing them. For example,

dua kali satu, dua	2 × 1 = 2 two times one is two
dua kali dua, empat	2 × 2 = 4 two times two is four
dua kali tiga, enam	2 × 3 = 6 two times three is six
…	…
dua kali dua belas, dua puluh empat	2 × 12 = 24 two times twelve is twenty four

If the children forgot the verse (the multiplication table), they went on by humming its melody. It could also be sung in the English language. For instance, for the multiplication table, they use the melody for the "Happy Birthday" song, and for "*Subtraction up to* 1000," they use the melody for "*A thousand legged worm*". It is really interesting when all the children sing together.

Mathematical game or song such as "*Pukul berapa Datuk Harimau*?" (What is the time Mr. Tiger?) attracts the children's interest. Other mathematical songs are "10 *Budak Hitam*" (10 Black Boys) and "*Anak Ayam Turun* 10" (10 little chicken) which are suitable to be sung or played when the children are on a long excursion trip, just to keep them occupied, rather than letting the time goes by without doing anything. For a longer journey, for instance from Kuala Lumpur to Kuantan, the song "10 Black Boys" could be lengthened or extended to "20 Black Boys". This will then needs the creativity of the children to arrange the verses; in order to match with the words nineteen until eleven. For the Malay version, they have got to match *sembilan belas* until *sebelas* with words ending with "*-as*" such as *batas, cantas, deras, kapas, kertas, lemas, malas, palas, pantas, paras, pentas,* and *tetas*. For a simpler song, which does not need variation of words, they could try the following rhyme:

N bananas on a box
N bananas
Take a banana, give it to your friend at the back
N – 1 bananas.

They could begin the song with *N* = 10, 20 or up to 100 (see Renteln & Dundes 2005).

The song "*Anak Ayam Turun* 10" is more difficult and challenging, since the children have to be more creative, especially if they sing "*Anak Ayam Turun* 20".

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Mathematics can be both enjoyable and interesting. Rather like completing a word puzzle, there is a great deal of satisfaction in working your way through a mathematical problem and coming up with the correct solution. There are no grey areas to worry about – you are either right or wrong. Of course, a lot of the popularity of mathematics depends on how it is taught, since a lack of enthusiasm and inspiration often reflects in how effectively the subject is received by the students.

Teaching in schools

The teaching of mathematics in school should not only consist of the "must know". That is teachers do not only teach the topics in the syllabus. It should also consist of the "should know" and the "good or nice to know". These three things could make mathematics not a boring subject, interesting to learn and the students want to learn more about the subject. For instance, if in school students are taught about even and odd numbers tell them also about the existence of other numbers such as perfect numbers, amicable numbers, square numbers and cubic numbers. In school students are taught:

The "*must know*":

If $x + 5 = 7$ (1)

then $x = 7 – 5 = 2$. (2)

Students are not taught how they really get the second step. This is the "*should know*":

Actually to get the second step, that is to make x the subject of the equation, we have to eliminate 5 from equation (1) by adding –5 (negative 5) to the equation.

Adding –3 to equation (1): $(x + 5) + (–5) = 7 + (– 5)$

Then we use the associative law for addition of numbers:

$x + (5 – 5) = 7 – 5$ giving $x + 0 = 2$.

Since 0 is the identity with respect to addition, thus we have $x = 2$.

The "*good or nice to know*": Students will be interested to know that actually we can use our fingers to do multiplication of numbers, to learn about magic square; that they can use mathematics to do magic: guess a car registration number, a birthday date, identity card number or the amount of money your friend has in his pocket.

When teaching algebraic equations (linear, quadratic and cubic equations), it might be an inspiration to the students if the teacher tells them that these equations lead to the discovery of group theory which they will be studying if they do mathematics in the university. Even though each concept that has been introduced is

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followed by a few examples, students still find difficulty in understanding the examples given because they do not really understand the concept just introduced. To grasp the theorems (and the proofs) that follow will be more difficult. To lessen the students' difficulty and boredom, at least we try to include some historical background of the subject and its applications in our daily life or in culture. This might help to bring the students closer to the subject, and help them to a better understanding of the course. Normally, in a lecture, especially in Abstract Algebra or Analysis, the students get bored and sleepy. This is the time to crack some jokes or humor, if possible, mathematical jokes or mathematical humor. Most mathematical humor are based on words involving standard mathematical concepts. Most of the humor involves food, which indicates the existence of mathematical concepts that are difficult to digest or swallow. Consider the following humor.

Q: ***What's purple and commutes*****? A: An abelian grape**.

Note: In abstract algebra, if the binary operation on a group commutes, then the group is called an abelian group. Grape sounds like group.

Q: ***Why did the mathematician name his dog "Cauchy"*****? A: Because he left a residue at every pole.**

Note: In complex analysis there is a result called Cauchy Residue Theorem.

Q: ***Why can't you grow wheat in*** **Z/6Z? A: It's not a field.**

Note: Of course wheat can only be grown in a wheat field. In abstract algebra **Z**/6**Z** is not a field, it is only an integral domain.

Q: ***What is grey and huge and has integer coefficients*****? A: An elephantine equation.**

Note: We have diophantine equation in number theory.

Q: ***What does a topologist call a virgin*****? A: Simply connected.**

Q: ***Who is a topologist*****?**

A: Someone who could not differentiate between a doughnut and a tea cup.

Applications of Mathematical Knowledge in the Workplace

What are in the secondary syllabus and textbooks are mostly arithmetical applications such as profit and loss, discount, commission, interest rates, hire purchase, money exchange and taxation. But what about workplace uses of algebra, geometry, trigonometry and calculus? Usually, many of these applications are beyond the level of most students. However, this section will illustrate some suitable real-life applications which teachers can discuss with their students.

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Quality of Life

Some students may question the purpose of understanding everyday events and analysing newspaper reports as outlined above. The American philosopher and educational theorist John Dewey (1859−1952) believed that education was a process of enhancing the quality of life. "By *quality*, Dewey meant a life of meaningful activity, of thoughtful conduct, and of open communication and interaction with other people." (Hansen, 2007, p. 9) If people are ignorant or cannot make sense of the events that happen during the daily course of their lives, then they may not be able to engage in meaningful discourse with other people, make well informed decision and lead a life of accountable conduct. However, some people think that life will still go on if they do not understand all these. But ignorance is not bliss. They may make bad ill informed decisions because they do not understand, for example, the spread of the HIN1 flu virus as reported in the media. Some elderly people think that they are immune to the virus since it attacks mostly young adults with medical problems (personal communication), and so the former may not take any precautions; this not only affects themselves but they may end up spreading the virus to others. Hence, knowledge and the ability to reason logically are necessary not only for leading a meaningful life but also a responsible one.

Other Generic Examples

It is usually not possible to find a real-life application for every topic that students can understand. But there are applications that teachers can still discuss with their students without going into specific details. For example, complex numbers are used extensively in electrical engineering to understand and analyze alternating signals (United States Naval Academy Website, 2001); GPS (global positioning system) makes use of complex vectors and geometric trilateration to determine the positions of the objects (Wikipedia, 2009a); and land surveying equipment uses trigonometry and triangulation (Wikipedia, 2009b). Teachers can also let their students have a sense of how the latter works by using a clinometers (a simple instrument that measures the angle of elevation), a measuring tape and trigonometry to find the height of a tree or a building (for more details and a ready-to-use worksheet, see Teh, Loh, Yeo and Chow, 2007a, pp. 108-111). Another example is the use of the formulae for finding arc length and sector area, and the symmetric and angle properties of circles, in the design and building of road tunnels, bridges, buildings and any shaped structures. Teachers can let their students have a sense of how this works by getting them to draw an arc-shaped balcony. Many students are interested in songs and so using an example on singing may capture their attention. The inventor is Andy Hildebrand who has worked for many years in the oil industry by providing an accurate map of potential drilling sites using sound waves sent into the ground and recording their reflections. This technique, which uses a mathematical formula called autocorrelation (refer to Wolfram MathWorld Website, Weisstein, 2009b, for more information), has saved oil

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companies lots of money and allows Hildebrand to retire at 40! After retirement, at a challenge from a dinner party guest to invent something that would allow her to sing in tune, he invented Auto-Tune, which also uses autocorrelation. Even if students do not know how autocorrelation works, they may be impressed that a mathematical formula can allow a person to earn so much money that he can retire at 40! This shows the usefulness of mathematics in the workplace.

Conclusion

Mathematics is of practical value in many professions. It is not just the mathematical knowledge itself but the thinking processes acquired in genuine mathematical problem solving and investigation that can be applied to unfamiliar situations in other fields. Mathematical knowledge and processes are also useful outside the workplace in everyday life to understand and interpret certain events and news reports so as not to be deceived or swayed by others' opinions without any reasonable basis, thus improving one's own quality of life when one is able to lead a meaningful and responsible life. Teachers should impress upon their students the usefulness of mathematics in their daily life, and they should prepare their students for the future by focusing on the essential skills and processes that are required in the workplace. The purpose of University Education is only to open the minds and enable one to perceive new problems and seek solutions. Education is only a ladder to gather fruits and not the fruits itself. It is up to the people to keep pace with advances in science and technology and adapt them to the constantly changing environment.

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