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Editorial Note

We extend acknowledgement to our benevolent readers on the occasion of successful completion of "AMC Journal" "Research Publication of Research Management Cell (RMC)", Aishwarya Multiple Campus (AMC), Dhangadhi, Kailali. The RMC of Aishwarya Multiple Campus has completed the first issue of the year 2018, (Vol. I). It serves the purpose of readers who are interested in contemporary knowledge of natural and social science. It includes two sections. Section A includes articles related to natural science and section B includes articles related to social science.

Encouraging support of our benevolent readers, scholars, academicians, and members of advisory board inspired us to come up with this issue of the journal on time. It contains basically 12 articles. Among them 7 are related to natural science and 5 are related to social science. This journal gives priority to the research work or project work conducted by the teachers and the students of AMC. Its main aim is to inspire the research scholars, teachers and students of the campus to write something about what they do, feel, and observe. The research course has taken different modes like thesis writing, field work report, project work report, and term paper assignments as integral part of the teaching and learning procedure. Publication of these research oriented activities in such type of journal encourages teachers as well as students in order to improve teaching and learning, and to enhance analytical and research skills.

We collected all articles from scholars of different fields and sent these articles for peer review work to related experts for their valuable suggestions, then we advised the writers to correct those articles. Finally, we again compiled all articles and edited them. This whole work was not possible without the sincere effort of the members of publication committee (Research Department), peer review team, editorial board, and advisory board. Long-time efforts and inspiration of these committees as well as benevolent creditors have made it possible to bring this issue into its present form. Therefore, we are always indebted to all learned scholars who have contributed their papers to publish this issue in time and valuable form. We also extend our gratitude to the advisory board and editorial board for their considerable assistance and sincere guidelines. We are further thankful to Prof. Dr. Hem Raj Pant, Prof. Dr. Chet Raj Bhatta, Prof Dr. M.L. Sharma Bhushal, Associate Prof. Dr. Mandev Bhatta, Dr. L.B. Thapa, and Mr. Bhuwan Bahadur Bohara, for their sincere devotion to review articles of this issue. We are indebted to campus chief Mr. Dharma Dev Bhatta of AMC for his valuable support to publish this issue. We are also thankful to Mr. Kamal Prasad Bakhariya for this painstaking computer work.

Despite sincere efforts, the chance of human error cannot be avoided. Therefore, we would also like to take full responsibility of any kind of deficiency presented in the editorial aspect of this issue. Lastly, we expect creative comments and suggestions from learned scholars and readers for the forthcoming issue.

Publication Committee Research Management Cell (RMC) Aishwarya Multiple Campus; Dhangadhi Oct. 2018

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SECTION - A NATURAL SCIENCE





Allelopathy: A Mechanism of Alien Plant Invasion in Nepal



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Abstract

This review aims to present a concept of allelopathy, allelochemicals and action mechanisms. As a biological phenomenon 'allelopathy' is one of the important mechanisms of alien plant invasions, effect of some forest killer alien plant (Banmara) species on Nepalese native trees through this mechanism should be highlighted. A discussion on leaves and litters of Banmara plant as the sources of allelochemicals and some of the control measures of alien species are discussed herein.

Introduction

The term allelopathy was first introduced in 1937 by Austrian scientist Hans Molisch to indicate the effect of one plant to another (Willis, 2007). One plant species may produce variety of chemicals which might be attractants; stimulators or inhibitors for other species and through these chemicals plant species interact or communicate each other. The term allelopathy is used for such interactions among plant species in a community.

The mostly accepted definition of allelopathy is given by Rice (1984). He defines allelopathy as "any direct or indirect, harmful or beneficial effect of one plant on another through the production of chemical compounds that are released into the environment". However, in ecology, the term has been popularly used for negative effects of chemicals produced by one organism upon another.

Theophrastus (300 BC) had noticed some harmful effect of cabbage on vine and suggested that it was due to odour (Rice, 1984). According to Pliny the Elder (AD 23-79), a great Roman author, stated that "*the nature of some plants though not actually*

deadly is injurious owing to its blend of scents or of juice" (Weston, 2005). The *Rigveda* and *Yajurveda* also indicate that crop rotation was practiced in ancient India long before it was advocated in Europe (Willis, 2007). These *Vedas* explains the ill effects of cutting of trees and the poisoning of the atmosphere (Renugadevi, 2012). These effects of plants are considered as the allelopathic effect.

A common phenomenon i.e. some plants cannot grow well in close association and some negative impacts on soil is observed due to repeated cropping. A Swiss botanist De Candolle was the first who suggested that soil can be sick due to crop exudates (Ma et al., 2011). Rice (1984) and Putnam (1985) reported that the plant tissues of leaves, fruits, stems and roots contain number of chemicals (called allelochemicals) and if one plant releases such chemicals other plants can be harmed or affected in some ways. From late eighteenth and early nineteenth centuries allelopathy has become a topic of broad interest with development of various techniques like plant extraction, bioassays and chemical isolation (Willis, 2007).

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Alien Invasive Plant Species

The term invaders and invasion in an ecological context was first described by Elton, "the father of invasion ecology", in his classical book on invasion (Elton, 1958).Since, then a number of definitions of invaders and invasion have been proposed. Invasive species are recognized as one of the major threats to native species and ecosystems around the world (Kathiresan, 2004; Kathiresan *et al.*, 2005).

Alien species which locally becomes dominant and invade natural communities, are referred to as invasive species. Invasive Alien Species (IAS) is non-native or exotic to ecosystems which are introduced to a new geographic area from their known historic range. IAS may include plants, animals, and microbes that have been transferred accidentally or with intent of economic benefits (Holmes et al., 2009). Sometime their history of origin and distribution might not be clear but their global expansion and distribution is accelerated due to global trade and human mobility (Meyerson & Mooney, 2007). Invasive weeds are more successfully colonizing in any natural habitats due to their faster rate of growth, biomass production, efficient dispersal of seeds and propagules, rapid colonization and establishment in comparison to native species.

A total of 166 invasive alien plants species of Nepal were noted by IUCN (Tiwari et al., 2005). The world's 100 worst invasive aliens (Tiwari et al., 2005) include 11 plant species like Arundo donax, Chromolaena odorata, Eichhornia crissepes, Hedychium gardnerianum, Hiptage benghalensis, Imperata cylindrica, Lantana camara, Leucaena leucocephala, Mikania micrantha, Opuntia stricta and Rubus ellipticus that are found in Nepal. However, they are not equally invasive. Seven toppers alien invasive in the list for Asia Pacific region include: Ageratina adenophora, Ageratum conyzoides, Chromolaena odorata, Eichhornia crissepes, Lantana camara, Mikania micrantha and Parthenium hysterophorus. All these seven species are problematic in Nepal.

IUCN (2000) defines IAS as an alien species, which

becomes established in natural or semi-natural ecosystems or habitat, an agent of change, and threatens native biological diversity. Invasive plants are usually non-native species that have been introduced intentionally or by accident and spread from human settings into natural areas with negative effects on our economy, environment, and health. Invasive plants usually possess traits that make them effective invaders, such as a short life cycle, high growth rate, large number of seeds with good dispersal ability, and good colonizing capacity.

However, in Nepal little data of scientific investigation regarding alien invasive plant species and its impact on environment. It is hoped that this paper come up with information and may develop management options capable of controlling aggressive invasion of alien invasive plant species.

Impact of Allelochemicals

There are several plant species which contain different types of chemical compounds that are beneficial or harmful to others if they are released out. Such chemicals released from plant species having allelopathic influences are termed as allelochemicals. The various allelochemicals and their impact on plants are as; aliphatic compounds (methanol, butanol, oxalic, formic, butyric and lactic acids) inhibit germination of seeds and growth of plants; unsaturated lactones (patulin, penicillic acid) inhibit growth of microorganisms and higher plants; fatty acids and lipids of one alga inhibits growth of another alga (Rice, 1984) and terpenoids have allelopathic effect on certain crops and weeds (Lin et al., 2007). Similarly, the cyanogenic glucosides (dhurrin and amygdalin) have allelopathic effect on various crops (Prati and Bossdorf, 2003) and alkaloids (cocaine, caffeine, quinine) inhibit germination of seeds in many plants (Rice, 1984).

Aromatic compounds like **simple phenols** show inhibitory effect on growth of several plant species (Rice, 1984); **cinnamic acid**, **benzoic acid**, **quinones and their derivatives** (caffeic, coumaric and ferulic acids) released by *Perthenium*,

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cucumber, sunflower etc. have inhibitory effect on variety of crops and weeds (Yu and Matsui, 1994; Rice, 1984). Various plants such as *Avena*, *Ruta* and *Imparata* release **coumarins**; apples release **flavonoids** (phlorizin) and many plant species produce **tannins** as allelochemicals (Rice, 1984).

How Do Plants Release Allelochemicals?

As per the study of various authors, the different process of allelochemicals are listed as;

Volatilization

Plants produce terpenoids and monoterpenes in the form of gases to the atmosphere. For example, *Eucalyptus* releases terpenoids which is toxic to germination and seedling growth of crops (Rana Devi *et al.*, 1997), *Brassica* members release volatiles that inhibit germination and growth of wheat and lettuce (Haramoto and Gallandt, 2004). *Amaranthus palmeri* releases octanone, nananone, heptanone as volatiles that inhibit germination of tomato, onion, carrot (Bradow *et al.*, 1992) (Fig. 1).



Fig. 1: Mode of release of allelochemicals

Leaching

Leaching is removal of substances from plants by the action of rain, snow, fog, dew etc. Many compounds from plant parts can be extracted through rainwater and mixed into soil. The compounds like phenolics, terpenoids and alkaloids have toxic effects on surrounding plants and microorganisms under field and laboratory conditions (Rice, 1984). For example, *Datura stramonium* produces benzylamine and scopolamine which inhibit growth of wheat and soya bean (Yasmin et al., 2011).

Root Exudation

Several compounds are released from roots of plants. For example, *Avena* species releases scopoletin which inhibits shoot and root growth of wheat, and wheat can produce hydroxamic acid that affects growth of wild oats (Perez and Ormeno, 1991). *Medicago sativa* releases canavanine inhibits growth of maize, barley, radish, cabbage and tomato (Miersch *et al.*, 1992).

Decomposition of plant residue

Decomposition of plant residue affects young crop plants in growth and productivity. Perthenin, coronopilin, caffeic acid, coumaric acid etc. are released from decomposed materials from *Parthenium hysterophorus* which can harm germination of various seeds (Patel, 2011).

Action Mechanism of Allelochemicals

Most of the studies focused on negative effects of allelochemicals. Allelochemicals primarily interfere cell division, production of plant hormones, membrane stability and permeability, germination of pollen grains, mineral uptake, and movement of stomata, pigment synthesis, photosynthesis, respiration, amino acid syntheses, nitrogen fixation, specific enzyme activities and conduction tissue (Rizvi *et al.*, 1992 and Wink *et al.*, 1998).

Plants release allelochemicals not only to interact with other plants but also with animals and microbes. For example, hydroxamic acids deter aphid feeding and decrease aphid survival and reproduction (Niemeyer and Perez, 1995). A compound gramine found in many plants is toxic to sheep, cattle, insects, pathogenic fungi and bacteria (Corcuera et al., 1992). Phenolic compounds affect pH, potassium (K⁺) and soluble chloride (Cl⁻) in the soil. The phenolic compounds may form complexes with nutrients and influence nutrients turn over in soil. Moreover, allelochemicals may also induce genetic changes within associated plants. For example, chemicals from Ailanthus altissima are responsible for altering the genetic pool of neighboring plant species (Kruse et al., 2000).



Allelopathy, Plant Invasion and Solution

Some plant species of one geographic region after migration to another region become highly aggressive in colonization. For example, Ageratina adenophora (Banmara) is becoming problematic species in Nepal as it has been growing aggressively on the road side, fallow land and forests. This plant had come to Nepal from Mexico through Indian boarders during 1950s (Tiwari et al., 2005). Such plants are called alien plants and they are called invasive plants if they are creating various impacts in soil, ecology, other native plants and people's livelihood (Tiwari et al., 2005). Now, the Banmara has become naturalized in Nepal and again shifting towards northern colder regions. One of the reasons behind aggressive colonization (invasion) of Banmara and other alien plants is the allelopathy (Timsina et al., 2011; Thapa et al., 2016a, 2017).

The different species of Banmara in different ecological zone of Nepal are; (i) Ageratina adenophora (Kalo Banmara) is distributed throughout Nepal (ii) Chromolaena odorata (Seto Banmara) is distributed in eastern and central parts of the country (iii) Mikania micrantha (Lahare Banmara) is distributed in east, central and western Nepal (iv) Lantana camara (Kade Banmara) is spreading throughout country. In tropical to subtropical regions of Nepal all these alien invasive species are creating severe problems by harming Nepal's indigenous flora and fauna. Prolific growth and severe colonization of these species is favored by their allelopathic effects (Gooden et al., 2009; Thapa et al., 2016a, 2017).

In Nepal, there are 26 alien species (native to tropical Americas) categorized as the invasive species with negative impacts on ecosystem functioning, native species richness, composition, growth and development (Shrestha, 2016). The allelopathy is common mechanism found in most of these invasive alien species as the means of wide spread and successful invasion.

Thapa *et al.* (2017) and others suggested that fresh leaves and litter of **Banmara** species are highly

allelopathic. They inhibit seed germination, seedling growth and development of Nepal's indigenous species such as *Shorea robusta* (Saal), *Alnus nepalensis* (Uttis) and *Schima wallichii* (Chilaune) (Thapa *et al.* 2016b; 2017). It is also found that **Kalo banmara** has ability to accumulate soil microorganisms which favor their growth and development while the beneficial microorganisms for Nepal's indigenous species are inhibited (Balami *et al.*, 2017).

Control and management of invasive species has become a great challenge in Nepal because national policies, management responses, research and studies are insufficient. Thapa *et al.* (2016a, 2016b, 2017) suggested that forest canopies should be maintained so that **Banmara** species cannot invade in shady areas, indigenous plant densities should be high to reduce **Banmara** phytotoxicity and **Banmara** litter should be removed or the plant should be removed physically before rainfall start. Application of the suggestions could contribute to reduce the negative impacts of **Banmara** and other invasive species in Nepal.

Conclusion

Allelochemical is the treatment of plant species in same ecological zone or vice-versa but most of the allelochemical compounds released from the alien invasive plant species. These invasive species create severe impact on environment by their spreading nature, growth rate, seed size and weight, seed production rate, nature of migration, toxic effect, etc. The need of present generation is that to manage aggressive colonization nature of these alien invasive plant species for safe and sound economy, natural resource conservation, diversity composition, eco-tourism and environment.

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Bee Keeping Practice in Dhangadhi Sub Metropolitan City, Kailali,



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ABSTRACT

The study primarily deals with "Bee keeping system in Dhangadhi," sub metropolitan city. The Dhangadhi city is one of major business hub of far western development region. This study provided information on the wholesale and retail price of honey in market, people attitude towards unsupported, bee keeping problems in Dhangadhi, Social-economic condition of Bee keeper, Major Bee available in the bee keeper, quality and demand of honey available in Dhangadhi.

The present study interviewed 8 Bee keeper, 12 honey retailers and 120 consumers, the suitable bee for terai region is Apis cerana. It is small in size, first of all these bees are imported from European country to Nepal. Beside these Bees, a number of bee's species Apis melifera, Apis dorsafa, Apis cerana, Apis Indica, are popular in Nepal. As honey is highly considered as sugar rich commodity. The honey is taken as medicine, food or Nutrition etc. That is why 70% of consumers mentioned honey consumption. Bee keeping in Dhangadhi is hindered by limited market places, unstable government policies regarding to aquaculture, unhygienic storage, higher cost production lack of experienced and knowledge etc.

The Economic condition of bee keeper is poor due to their illiteracy, insufficient agriculture lands, and unemployment. They usually tall's below poverty line, therefore the levels of education are low and awareness. For the prevention of bee diseases there are many type of process like Sulpher, formic acid, abscic acid etc adopted by bee keeper in Dhangadhi. The study indicates that there is great potential to substitute the imported volume through commercial production, post harvested management and improving efficiency of bee keeping system within Dhangadhi

1. INTRODUCTION

Nepal is a landlocked central Himalayan country in south Asia. Nepal has a diverse geography, including fertile plains, subalpine forested hills. There are more than 20,000 species of bees grouped as super family Apoidal in the insect order Hymenoptera (crane, E., book of honey bee). The most familiar bees are the social ones which provide man with honey and wax. The true honey bees (the genus Apis) are a biologically well defined within the family Apoidal.

Indigenous species of honeybee found in Nepal are *Apis cerana, Apis dorsata, Apis laboriosa.*



Fig A. melifera

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At present there are two species of hive honey bees are available in Nepal indigenous Apis cerana and exotic Apis mellifera. The cavity nesting honey bee Apis cerana is native to sourthern and estern Asia, therefore, called Asian hive bee. It is very similar to Apis mellifera in nesting and dancing behavior and in building of parallel combs. However, they show several other distinct differences. Apis cerana is well developed to the local climates environment and native flora. It is widespread upto 3000 meters throughout the country. It is gently in temperament, industrious, mitts resistant and can be handled easily. The honey yield of Apis cerana varies between 10-12/ kg/colony/year. However, this species has not become popular among the commercial beekeeper because of its low yield and frequent swarming, absconding and robbing behavior. The main objectives of the study were to analyze the opportunities of the bee keeping, determine the storage method of honey applied by bee keeper, identify the annual honey production , find out the type of species of honey bee used in beekeeping by the beekeeper and know the diseases control methods of bees used by beekeepers in Dhangadhi.

METHODOLOGY (MATERIALS & METHODS)

Study in Gugeda (Gau-A) Guged (Gau D), Matiari, Manhera ,Bangra Katan, Dhangadhi gaun, urma, katan.



(source : Google map.)

In order to gets a representative image of bee

keeping system in Dhangadhi, the total of 12 honey traders (retailers) were selected for questionnaire interviews. A total of the 120 consumers were also interviewed at the market centre. In addition, a total of 8 beekeepers were interviewed. A well structured questionnaire was used for interviewing with bee keeper, honey traders, and consumers. The field survey was undertaken for five months from Poush 15 to Baishak 15, 2075. Collection methods were divided in two steps, these were Questionnaire interviews and direct observation.



Fig:-steps of data collection methods

For questionnaire survey, bee keepers were selected through simple random sampling method.

Statistical and graphical analysis were done by Microsoft excel. The primary data was analyzed by making pie chart, graphs and different tables

Sampling statistics are used to test whether the observed difference between two numbers is larger enough to be considered statistically. It represents the proportion of any variable in term of its total.

RESULT

1) Analyze the opportunities of beekeeping in Dhangadhi

Beekeepers, marketing sellers and consumers opinion on opportunities in beekeeping in Dhangadhi.





| Opinion | number of respondent Beekeepers + honey sellers | Percentage | | |
|---------|--|------------|--|--|
| Good | 30 | 20% | | |
| Better | 45 | 30% | | |
| Best | 75 | 50% | | |
| Total | 150 | 100% | | |
| | | | | |

Source: field survey, Dhangadhi



Beekeepers, honey sellers and consumers opinion on opportunities of beekeeping in Dhangadhi

From the above study 50% intervieweers said the opportunity in beekeeping is best 30% said better and 20% said it is good.

2) The Storage method of Honey

Storing honey is straight forward process. To keep honey fresh, we need to find an appropriate container in which we need to store the honey and need to keep this container in a cool dry place. If honey is to be stored for long term use, it can be frozen and then thawed out later.

Storing Honey for short term use

Choosing the right container, if necessary:

Honey can be stored in the container after its extraction immediately. However, if container is damaged or leaked, honey can be transferred to another container. Honey can be stored in any of the following instruments like plastic buckets, containers, glass jars, mason jars.

Selecting a room with a consistent temperature

Bee keeper and traders the favorable range of temperature used is 10° C - 20° C. According to the information the Sunlight can also damage honey. So it is better to keep honey in a darker place. For long term storage. Honey is stored in the freezer for preventing crystallization. Honey is simply kept in and air tight container and allowed it to gradually thaw out at room temperature.



Fig: Methods applied by different beekeepers to store honey

From above information it is found that 73% Beekeepers use short term method of storing honey and 27% use long term method of storing honey in Dhangadhi.

3) The annual honey production in Dhangadhi:

Apis mellifera produces honey two times in a year. The 1st time is during the summer (march-may) and 2nd time during the winter (Nov-Dec). Honey is produced depending on the seasons. In winter season, honey is produced more and in summer season it is produced less because in winter season the main raw materials (i.e mustard flower and honey dew) for honey is available easily but in some season the raw materials are not available easily.





| Date | No. of beehive | Summer (kg) | Winter (kg) | Total (kg) | |
|------|-------------------|----------------|----------------|---------------|--|
| 2070 | 100 | 3400 | 3900 | 7300 | |
| 2071 | 115 | 4025 | 4370 | 8395 | |
| 2072 | 120 | 4080 | 4680 | 8760 | |
| 2073 | 120 | 4320 | 4560 | 8880 | |
| 2074 | 130 | 4160 | 5200 | 9360 | |





Fig: Annul production of honey in Dhangadhi

From the above survey, in Dhangadhi beekeepers usually nourish *Apis mellifera* than *Apis cerana*.Day by day the honey production is increasing in Dhangadhi due to high demand of honey. According to the above table, every year bee keepers are increasing the number beehives and production of honey. From the Dhangadhi every year approximately 7-8 quintal honey is export to another place like Mahendranagar, Nepalgunj, Kathamandu etc.

4) Types of honey bee species used in dhangadhi:

In Dhangadhi mainly two species of bees are cultured i.e. *Apis mellifera and Apis cerana*. Rarely other species are also found to be cultured. We went to the 8 beekeepers and found following results:-



Species cultured by beekeepers in dhangadhi

From observation we found that about 47% of *Apis mellifera* are cultured in dhangadhi, 40% *Apis cerana* are cultured and 13% other species are cultured. *Apis mellifera* is cultured more because it is more profitable and produces more honey.

5) Diseases control method of bee used by beekeeper in Dhangadhi

According to this survey in Dhangadhi, beekeepers have used many types of method to control the disease of bee. They are as follows-

Tite pati:

It is a one kind of shrubs which is used to treat the bees. From mites attack. Mites are easily died due to the smoke of tite pati and after that bees are released safely from mites.

Sulphur:

It is chemical substance for killing of mites. When the colony is affected, then the sulphur is mixed with water and by the help of tank spray, it is sprayed around the colony and mites and after that mites are killed by its chemical poison.

Calomel:

This is also chemical substance called kupur. It is used to control the parasite by its odor. It is kept near the affected colony and burnt, and then it produce a smoke which is very effective for preventing the parasites. So, it is used by beekeeper in Dhangadhi.

Formic Acid

It is a chemical substance to kill the parasite inside the body. It is sprayed around the infected colony and then taken during the sucking of nectar with the help of nectar. The chemical substance reaches inside the body and kills all type of parasites inside the body. It is used in every 6-6 month to protect bees from internal parasite.

Abanistic:

It is special type of chemical which is applied against the diarrhoea. When the digestive system is disrupted, or indigestion occur is bees then the

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abanistic apply for the treatment of indigestion or diarrhoea. The abanistic is mixed with water and sugar, and then kept on the colony, which is used to prevent diarrhoea. The bees suffering from diarrhoea come to near the abanistic solution and take the solution inside their body by the sucking. In this way the chemical substance reach inside the body of the effect bee and, the bee becomes fully healthy.

We visited various parts of dhangadhi and gather information about the control measures of diseases caused to bee. We visited 8 beekeepers at different places of dhangadhi and survey carried in dhangadhi helps us to know about the many types of method applied by beekeepers to control the diseases of bee. Following method are applied by the beekeepers to prevent the diseases:-



Fig: Diseases control method of bee used by beekeepers in dhangadhi

From above study it is found that tite pati and calomel method of diseases control are applied by most beekeepers and least applied method is formic acid and other methods are moderately applied.

DISCUSSION

Beekeeping was conducted to know the present situation of apiculture in Dhangadhi. Data were collected by questionnaire interview and direct

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observation. The bee keeping style varies with the types of species. *Apis mellifera and Apis cerana* are best cultured in Dhangadhi while, *Apis dorsata, Apis laboriosa, Apis florea, Apis meliponinae* are not suitable at this area.

Honey is an integral part of production distribution in beekeeping system. Honey is used by all people of Nepal. There is organized database and study of beekeeping system in Dhangadhi. Keeping their view in aspects, this study was designed to assess the apiculture in the Dhangadhi. Altogether 8 beekeepers, 12 honey traders as well as 120 honey consumers were interviewed using structured questionnaire. Beekeeping is male dominated business but female also do in some places. Most of the beekeepers are usually illiterates but they can know about the beekeeping by the help of training and practices. Nearly 75% of beekeepers are uneducated, 25% educated are found among surveyed beekeepers. They are very much interested to give education to their children, among whom ninety percent are sending their children to boarding school and ten percent are sending their children to governmental school, about forty percent of beekeepers don't know about family planning idea but only about 20% of them have taken benefit. Majority of the beekeeper are having the family 5 to 10 members. Beekeeping sector is one of the few sub sector that has the most inclusive ability to achieve transformation and growth across all categories of rural household (paulos, 2011) Dhangadhi is among the leading honey producer in Nepal and one of the ten largest honeyproducing city of Nepal. Thus, increasing production of honey and other beehive products will contribute to household food and income security. Honey can be marketed in several forms in local and foreign market and the price and demand of honey depends on the quality of that honey.

Major proportion of honey consumed in Dhangadhi is produced in Dhangadhi itself and few portions of honey is imported from India. The higher arrival in Nepal and India is recorded in



the month May due to religious work. More honey is generally consumed during the religious works and the cold season. Honey production was higher in winter and lower in rainy season. The major European honey bees species Apis mellifera are kept in Dhangadhi and other species Apis cerana, Apis dorsata, Apis indica etc. The Apis mellifera suffered from many types of disease like mites, parasites, diarrhoea, and paralysis. Among them 45% of bees suffer from diarrhoea ,33% of bees attacked by mites and 22% of bees attacked by paralysis. In Dhangadhi area, farmers usually use many types of drugs for preventing and controlling the bee's diseases. Mainly tite pati, sulphur, calonal (kapur) fomic acid, abanistic are used as a drugs to prevent and control the bee's disease in Dhangadhi.

In Dhangadhi there is more opportunity to do good in bee keeping. There are many forests that produce many types of flora for bees. About 80% of people are doing agriculture in Dhangadhi which is directly helping to apiculture. Nowadays the demand of honey and bee wax has increased because they are used for making useful substance in cosmetic and medicinal area. At present time government is also supporting apiculture which makes easy in doing apiculture. It is very useful business for unemployed people. It is easy to do and more profitable. Government is providing free training, some tools and loan at low interest for doing the apiculture.

Large volume of honey was produced in the Dhangadhi due to increasing demand of honey as honey is important food item. There is a great potentiality to develop the honey market through commercial production and diversification. Some problems for beekeeping were reported by beekeepers including lack of knowledge, lack of instrument, deforestation, disease and enemies, pesticide damage, limited market etc. Deforestation, enemies and diseases, limited market are the major problems. Nowadays people are using different types of pesticide in their crops; bees are affected by the high risk of pesticides. The main enemies of bees are mites, ants, spiders. They are killing the bees and many types of diseases are also affecting the bees. Illiteracy and lack of instrument s are also major problems.

A positive policy should be made at government level and implemented properly for sustainable bee keeping system. If the issue is properly addressed apiculture can greatly improve the living standard of a large number of populations involved in it. However bee keeping management is not properly addressed. The study indicates that there is great potential to substitute the imported volume through commercial production, post harvest management and improving efficiency of beekeeping system in Dhangadhi.

CONCLUSION

The present study, beekeeping system in Dhangadhi is conducted for five months (Poush to Baisakh). This study is helpful to gather the information about beekeeping in Dhangadhi. People's attitude towards beekeeping, idea about apiculture was observed. Bee keeping problem and honey storage methods were also observed during this survey. A total of 8beekeeper were selected through the simple random sampling method for answering the questionnaire in order to get information about bee keeping system in Dhangadhi. They were interviewed at their own farm. A total of 12 honey traders (retailers) were selected through simple random sampling method for questionnaire interview, information from 120 consumers were also collected through the simple random sampling method or questionnaire interview method. The study revealed that bee keeper usually engaged in beekeeping from 6:00 am to 7:30 pm every day. The market Chain from farmers to consumers passes through middleman to retailers. The method of bee keeping varies with the type of species. From the study we found that Apis mellifera is more suitable for bee keeping in Dhangadhi area while Apis cerana, Apis dorsata, Apis laboriosa, Apis florea, Apis meliponinae were not suitable for Dhangadhi area.

Nowadays, the beekeeping is rapidly growing. The apiculture is very profitable according to the

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beekeeper of Dhangadhi. The bee products, like honey, bee wax are very useful and their demand is growing day by day in market, so apiculture is rapidly growing in local area. The honey is valuable for, religious, medicinal, cosmetic and food. Like as bee wax also used in many sector like medicinal sector, cosmetic sector, candle factory etc. The study shows that there is the best opportunity in beekeeping as 50% of the beekeepers and honey sellers said and 20% said that it is good. From the study we also find that there are two methods of storing honey i.e. long term storage and short term storage method of honey.73% of the beekeeper use short term storage method and 27% use long term storage method. The study shows that the annual production of honey is also increasing per year as the demand of honey is increasing every year.

During this study we found that in Dhangadhi diseases seen in bees are paralysis, diarrhoea and mites. Among them, 45% of bees suffer from diarrhoea. Diarrhoea is common disease. It is worldwide disease so if one can suffer from this disease whole colony can be suffered. This disease greatly affects honey bees. 33% of bees are attacked by mites. varroa destructor and arroa jacobsoni are parasitic mites that feed on the body fluids of adult pupal and larval bees. 22% are attacked by paralysis. Paralysis is non communicable disease. There are two types of paralysis nervous system paralysis and stomachic paralysis. In nervous system paralysis bees cannot develop leg and wing due to disorder of nervous system and in stomachic paralysis bees cannot feed anything due to poor development of digestive system.

Mixed Indian honey should be banned and separate honey marketing with physical infrastructure like proper honey storage, pest management and Government support should be constructed. So, it is also necessary to providess training and some theoretical knowledge to beekeepers and honey traders about proper beekeeping and storage of honey. A positive policy should be made at government level and implemented properly for sustainable bee keeping system.

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GM Crops And Ethical Concerns : A Review



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Abstract

This article represents a review of various ethical issues that have been raised as a result of the development of genetically modified (GM) organisms. There are a number of ethical concerns over transgenic crops which have affected public support of the products. These issues have also put forward many doubts about the production and commercialization of GM crops.

This article addresses major points of conflicts which have drawn considerable attention in biotechnology sector in the world. There have been considered risks and benefits to the environment resulting from genetic modification of crops, in addition to effects on biodiversity. It may offer the base for a profound debate on pros and cons of these crops for human health and ecosystem.

The arguments provided in the article concerning transgenic crops are based on the available information and research on this subject.

Introduction

Genetically modified organisms are made by modification of an organism's genetic composition by artificial means. It involves the transfer of specific genes from one organism into a plant or animal of entirely different species. Biotechnology has enabled us to exchange genetic materials within or across species boundaries to produce improved or totally new organism.

The use of recombinant DNA technology has enabled the isolation and combination of desired genes to obtain a new DNA. *Agrobacterium* has been successfully used as an intermediate organism for transferring a desirable gene into plants (*Caiping MA*, *Plant Mol Biol Rep.2004*). Biolistic transformation is a physical method by which the genes of interest are bombarded into the plant cells and DNA coated beads are usually used as carriers (*J Mator Sci. 2003*).

Another technique which facilitates the incorporation of gene into the host genome is called Electroporation. DNA enters the plant cells through minute pores which are temporarily caused by electric pulses (*Obert B.2004*). Another recent method consists of Microinjection which is direct introduction of DNA into genome (*Darabani B. 2008*).

An organism generated through genetic engineering techniques is considered to be a

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genetically modified organism (GMO). The first commercially released genetically modified crop was *Flavr Savr* tomato which was engineered for longer shelf life.

At present more than 200 million hectares of land are under cultivation for biotech crops throughout the world (*Knight B.2007*). There has been a 60 fold rise in the application of crop biotechnology since the commercial release of first Biotech crop in 1996. Major producers of GM crops include USA, Argentina, Canada and China (*ISAAA*, US 2007). Developing countries are deeply interested to adopt the technology with the hope of providing economic benefit to the farmers and food security for the growing population as well.

The development of agricultural biotechnology has created social and ethical conflicts. A significant amount of discussion has been stimulated on the merits and demerits of genetic engineering of crop plant. Different views on agricultural biotechnology have given rise to serious contradictions between advocates and opponent of GM crops.

Major Concerns

Majority of current GM crops available in the global market have been genetically modified to increase resistance to insects or viruses, tolerance to certain herbicides and enhanced nutritional contents. It is repeatedly stated by the proponents of GM crops that the crops expressing tolerance to various biotic and abiotic stresses lead to reduced requirement of fertilizers and pesticides.

On the other hand environmentalists have objections to transgenic crops on several issues relating to global ecosystem and the balance of nature. Production and commercialization of transgenic crops have resulted in various controversies of ethical, ecological and economic concerns which have raised questions on the significance of technology itself.

Impacts on the environment

Damage to the environment is major concern with regards to GM crops. Unfortunately, the technology is still new enough that scientists do not know exactly about the effects of GM crops on the environment. Long term studies take decades to complete and most studies of GM crops involve short term effects.

A major environmental concern associated with GM crops is their potential to create 'super-weeds' through cross pollinating wild relatives or simply by persisting themselves. The effects of such 'gene flow' on the environment are uncertain; however complete evaluation of individual crops is required before release as well as after commercialization.

Another ethical issue about GM crops is our ability to constrain them in a specific area. There are fears that if these crops do negatively impact the environment, they will spread in an out of control fashion and it will not be possible to stop their damaging effects.

In May 1999, it was reported that pollen from Bt insect resistant corn had a negative impact on Monarch butterfly larva (*Losey JE, Rayor LS, Carter ME, 1999*). This report raised concerns about potential risks to non-target organisms.

Concerns have been raised that engineered virus resistance in GM plants could result in evolution of new, stronger viruses. There is evidence that many targeted pest species have evolved resistance to engineered genes. Agrochemical control of crop pests is however, inefficient and environmentally unsound and genetic engineering could offer more precise targeting of pest management.

There have been concerns about genetic diversity and its possible erosion as the farmers have replaced the use of traditional varieties with monocultures. It may be unethical to treat the traditional forms of agriculture as markets to be conquered by private interests (Biopiracy). However it is argued that there is always a

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continuous experimentation going on for the development of more effective crops which helps to maintain genetic diversity.

Transgenics and human hunger

In the developing world, 840 million people are chronically undernourished while approximately 1.3 billion people do not have secure access to food (*FAO*, 2001). In addition the world's population is predicted to double over the next 40 years. To keep pace, the United Nations says global food production must increase by at least 40% in the face of decreasing fertile lands and water resources. Biotechnology as one of the many tools of agricultural research and development, can significantly contribute to food security in developing countries. The GM foods have the potential to solve many of the world's hunger and malnutrition problems.

The major causes of crop loss worldwide are biotic stress caused by pathogens, parasites and insects and abiotic stress particularly drought, salinity and temperature extremes. Examples of commercial GM crops in this area are the insect resistant crops expressing the Bt gene and the virus resistant GM papaya. At laboratory level, resistance has also been engineered to other biotic and abiotic stresses.

GM technology has the potential to engineer plants to express additional products that can alleviate malnutrition. An important example is 'Golden Rice Project' (Ye et al, 2000). Vitamin A deficiency is widespread in developing world and is estimated to account for deaths of approximately 2 million children per year (Nutr *Res Rev*, 2004) or causing blindness in surviving ones. Humans can synthesize Vitamin A from its precursor â carotene which is commonly found in many plants but not in cereal grains. The strategy of Golden Rice was to engineer rice endosperm to allow â carotene synthesis. Golden Rice was developed for farmers in the poorest countries and is an impressive example of a health solution that can be offered by plant biotechnology.

Transgenics and human health

Rather carelessly presented accounts of genetic engineering developments, by journalists and scientists have raised concerns that human health will be adversely affected by consumption of transgenic crops and products derived from them. A major worry of the public, aside from fundamental concerns, is that eating foods carrying 'antibiotic marker genes' would reduce the effectiveness of antibiotics to fight bacterial infections. The World Health Organization has judged antibiotic marker genes to be safe (*WHO*, *1994*) but the outcome of their use might be hazardous if they represent a source of resistance to a wide class of antibiotics.

Other principle concerns are that transgenic food will be toxic or allergenic. Few scientific data indicate that animals fed by GM crops have been harmed or even died. Rats exposed to transgenic potatoes or soya had abnormal young sperm (*Pusztai A.1999*); cows, goats, buffalo and pigs grazing on Bt maize and certain biotech corn showed complications like early deliveries, abortions, infertility and also many died (*Velimirov A.2008*). However this is a controversial subject as Agri-biotech companies do not accept the direct link between GM food consumption and human health problems.

Keller (1997) reviewed the consequences of GM food for toxicity and allergenicity. He concluded that several naturally occurring defense substances found in plants are highly toxic to mammals, but also indicated that food safety can be influenced by natural pathogens and their products. There has been no such evidence that GM foods pose more risks than non-engineered foods.

Human health already suffers as a consequence of agricultural practices. For instance, commercial Banana production requires application of significant amounts of pesticides which pollute the environment and whose residues may accumulate in humans. It seems to be ethically more justifiable to produce a transgenic Banana variety that would allow reduced pesticide

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requirement and subsequent improvement in human health.

Taking everything into consideration, there is a strong need for case-by-case assessment of transgenic plants for toxicity and allergenicity. Careful labeling of products would be informative for customers with allergies and for those averse to buying a product derived from transgenic crop.

GM food labeling

In order to verify the long term consequences of GM food on human beings, the law for mandatory labeling is highly required. However the labeling is not just health issue, it is about consumers' right to know what's in their food and make an informed choice.

A proper labeling represents "GM" word along with additional information on changed characteristics and the external source of the inserted gene. The law for compulsory labeling of genetically modified food products has been established in more than 40 countries (*CBC News Online, 2004*). However the opponents of GM food labeling are concerned that it will hold back the progress of Agri-biotechnology and also it would lead to extra cost and logistical difficulties.

Unexpected consequences

There are fears about genetic engineering that involves two vastly different species because the potential for unexpected consequences is seen as a greater issue. For instance, genes that are 'mixed' between animals and plants are major concern regarding GM foods. Tomatoes that have been engineered to have frost tolerance had genes inserted from flounder (*Alan*, 2000).

In view of the above, GM foods are still facing the public mistrust and worries about the long term consequences. Further, related to vegetarians and in particular, vegans, and this type of animal - plant transfer of genes is a major ethical issue.

Concluding remarks

GM crops have been subjected to criticism on several grounds from the beginning. Despite of the continued controversies and persisting arguments around GM foods, we cannot afford to ignore the potential benefits of these crops. There are concerns about the long term consequences of transgenic crops on environment and human health which raise the need for continuous vigilance and strict bio-safety testing guidelines to be followed by all the countries involved in production of GM crops.

There have been numerous conflicting studies about the safety of GM foods but these have shown mixed results and hence it would not be fair enough to conclude anything.

Taking everything into consideration, it is too late to keep the genie in its bottle (Mayer, 1996). Transgenic crops have been produced in abundance and research into genetic engineering is going to be continued.

The high yielding potential of GM foods along with desirable nutritional contents provides the best chance to end world's hunger and malnutrition problems. Farmers have been supporting the technology as it would help them to reduce cost and stop worrying about drought and other destructive environmental stresses.

Public acceptance is still one of the major challenges for the adoption of genetically modified food. There is still a wide gap between the enthusiastic acceptance of GM crops to be cultivated by farmers and a tepid attitude of consumers. There are several factors that can play a key role in public acceptance of genetically modified crops. Misinformed public debates on the issues related to transgene crops can create mistrust in the technology. In this context, there is need for clear and understandable consumer information about the potential benefits and constraints of GM crops.

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System of linear equations and its application in balancing chemical equation



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Abstract :

After the investigation of new mathematical theories, the next important task for a mathematician is to search the field of its application. This article specially focused on the application of topics of linear algebra such as homogeneous system of linear equations, matrix theory and reduction of matrices into its row reduced echelon form (RREF) in balancing the chemical equations. Starting from the concept of system of linear equation, elementary transformation of matrices and row reduced echelon form of matrix, a brief process of the application of these concepts in balancing the chemical equations is given in this article.

1. Introduction

1.1. A system of linear equations:

A linear equation in *n* variables $x_1, x_2, ..., x_n$ is an equation that can be written in the form $a_1x_1 + a_2x_2 + ..., a_nx_n = b$ where *b* and the coefficients $a_1, a_2, ..., a_n$ are real or complex numbers. 2x + 3y + 5z = 4 and $x_1 + 3x_2 + 4x_3 = x_2$ etc are examples of linear equation while $4x_1 - 5x_2 = x_1x_2$ and $x_2 = 2\sqrt{x_1} - 6$ are not linear because of the presence of x_1x_2 in the first equation and $\sqrt{x_1}$ in the second.

A system of linear equation is a collection of one or more linear equations involving the same variables $x_1, x_2, ..., x_n$. For example: The equations 2x + y = 5 and x + 2y = 3 form a system of linear equation in two variables x & y. Similarly, $2x_1 - 2x_2 + x_3 = 0$, $2x_2 - 8x_3 = 8$ and $-4x_1 + 5x_2 + 9x_3 = -9$ is the system of linear equation in three variables.

A solution of the system of linear equation is a list (s_1, s_2, \dots, s_n) of numbers that makes each equation a true statement when the values s_1, s_2, \dots, s_n are substituted for x_1, x_2, \dots, x_n respectively. A system of *m* linear equation in *n* variables is given by

 $\begin{array}{c} a_{11}x_1 + a_{12}x_2 + \dots + a_{1n}x_n = b_1 \\ a_{21}x_1 + a_{22}x_2 + \dots + a_{2n}x_n = b_2 \\ \vdots \\ a_{m1}x_1 + a_{m2}x_2 + \dots + a_{1n}x_n = b_m \end{array}$

This system of linear equation can be written in matrix form as



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Or,
$$AX = C$$
.

The system (*) of linear equation can also be written as

Or,
$$\begin{bmatrix} a_{11} & a_{12} & \dots & \dots & a_{1n} & \vdots & b_1 \\ a_{21} & a_{22} & \dots & \dots & a_{2n} & \vdots & b_2 \\ \vdots & & & & & & \\ a_{m1} & a_{m2} & \dots & \dots & a_{mn} & \vdots & b_m \end{bmatrix}$$

This matrix is called augmented matrix. A system of linear equationAX = C is said to be homogeneous if C = 0 (i.e. if it can be written in the form AX = 0) such a system AX = 0 always has at least one solution X = 0. this zero solution is usually called the trivial solution. The homogeneous equation AX = 0 has also a non zero solution called nontrivial solution. A system of linear equation has either i) exactly one solution or ii) infinitely many solutions or iii) no solution. If the system of linear equations has solution (i.e. exactly one solution or infinitely many solutions) then the system is said to be consistent. Similarly, if the system has no solution then the system is said to be inconsistent. Testing consistency and inconsistency of the system of linear equation is beyond this article.

There are so many methods of solving such a system of linear equations among them solution of system of linear equations by reducing to row reduced echelon form is most popular one. In this method the augmented matrix is reduced to row reduced echelon form by a finite sequence of elementary row operation.

1.2. Elementary row operations :

The following three operations are called elementary row operations.

- 1. Replacement: replace one row by the sum of itself and a multiple of another row.
- 2. Interchange or swap: interchange two rows.
- 3. Scaling: multiply all entries in a row by a nonzero constant.

The two matrices are said to be row equivalent if one can be obtained by a finite sequence of elementary row operations (or row transformation) of other.

1.3. Row reduced echelon form:

A matrix is said to be in row reduced echelon form, if

- i) The first non zero element of every non zero row is 1 called the leading 1,
- ii) Each column containing the leading 1 has all other elements zero,
- iii) The nonzero rows occur above the zero rows, if any,
- iv) The leading 1 of any row must belong to a column, to the right of the column of which the leading 1 of the previous row belongs. For example, the matrices

| 10 | 1 | 1 | 0 | 1 | | 1 | 0 | 0 | 4 | |
|----|---|---|---|---|-----|-----|---|---|---|--------------------------------------|
| 0 | 0 | 0 | 1 | 0 | and | 0 | 1 | 0 | 3 | are in the row reduced echelon form. |
| Lo | 0 | 0 | 0 | 0 |] | L 0 | 0 | 1 | 2 | |

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1.4. Row reduction algorithm:

The algorithms for the row reduced echelon form can be shown by following illustration.

Reduce the following matrix in the row reduced echelon form $\begin{bmatrix} 2 & 4 & -2 & 2 \\ 1 & 2 & -3 & 0 \\ 3 & 6 & -4 & 3 \end{bmatrix}$ Solution : The given matrix is, $\begin{bmatrix} 2 & 4 & -2 & 2 \\ 1 & 2 & -3 & 0 \\ 2 & 4 & -2 & 2 \\ 3 & 6 & -4 & 3 \end{bmatrix}$ $\sim \begin{bmatrix} 1 & 2 & -3 & 0 \\ 2 & 4 & -2 & 2 \\ 3 & 6 & -4 & 3 \end{bmatrix}$ By $R_1 \leftrightarrow R_2$ (ie R_1 and R_2 are interchanged) $\sim \begin{bmatrix} 1 & 2 & -3 & 0 \\ 0 & 0 & 4 & 2 \\ 0 & 0 & 5 & 3 \end{bmatrix}$ By $R_2 \rightarrow R_2 - 2R_1 \& R_3 \rightarrow R_3 - 3R_1$ $\sim \begin{bmatrix} 1 & 2 & -3 & 0 \\ 0 & 0 & 1 & \frac{1}{2} \\ 0 & 0 & 5 & 3 \end{bmatrix}$ By $R_2 \rightarrow \frac{1}{4}R_2$ $\sim \begin{bmatrix} 1 & 2 & -3 & 0 \\ 0 & 0 & 1 & \frac{1}{2} \\ 0 & 0 & 0 & \frac{1}{2} \end{bmatrix}$ By $R_3 \rightarrow R_3 - 5R_2$ $\sim \begin{bmatrix} 1 & 2 & -3 & 0 \\ 0 & 0 & 1 & \frac{1}{2} \\ 0 & 0 & 0 & \frac{1}{2} \end{bmatrix}$ By $R_3 \rightarrow 2R_3$ $\sim \begin{bmatrix} 1 & 2 & -3 & 0 \\ 0 & 0 & 1 & \frac{1}{2} \\ 0 & 0 & 0 & 1 \end{bmatrix}$ By $R_2 \rightarrow R_2 - \frac{1}{2}R_3$ $\sim \begin{bmatrix} 1 & 2 & -3 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$ By $R_1 \rightarrow R_1 - 3R_2$. This is required row reduced echelon form.

1.5. Solution of linear equations by reducing to echelon form:

The system of linear equations can be solved by reducing the augmented matrix [A : C] to fully row reduced echelon form. For example, the system of linear equation is

$$a_1x + b_1y + c_1z = a$$
$$a_2x + b_2y + c_2z = b$$
$$a_3x + b_3y + c_3z = c$$

The augmented matrix is $[A:C] = \begin{bmatrix} a_1 & b_1 & c_1: & a \\ a_2 & b_2 & c_2: & b \\ a_3 & b_3 & c_3: & c \end{bmatrix}$, By elementary row operation, this matrix is

reduced to fully row reduced echelon form (normal form): $\begin{bmatrix} 1 & 0 & 0: & p \\ 0 & 1 & 0: & q \\ 0 & 0 & 1: & r \end{bmatrix}$ then the required

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solution is x = p, y = q and z = r. Sometimes the system of linear equations can also solved by reducing the augmented matrix [A : C] to upper triangular form and then using back substitution method. The solution algorithm is shown in following illustration.

Solve the following system of linear equations.

$$3x - y + 2z = 1$$
, $x + 2y - z = 3$ and $2x - y + 3z = 2$

Solution:

The augmented matrix
$$[A:C]$$
 is $\begin{bmatrix} 3 & -1 & 2: & 1 \\ 1 & 2 & -1: & 3 \\ 2 & -2 & 3: & 2 \end{bmatrix} \sim \begin{bmatrix} 1 & 2 & -1: & 3 \\ 3 & -1 & 2: & 1 \\ 2 & -2 & 3: & 2 \end{bmatrix}$ By $R_2 \leftrightarrow R_1$
 $\sim \begin{bmatrix} 1 & 2 & -1: & 3 \\ 0 & -7 & 5: & -8 \\ 0 & -6 & 5: & -4 \end{bmatrix}$ By $R_2 \rightarrow R_2 - 3R_1 \& R_3 \rightarrow R_3 - 2R_1$
 $\sim \begin{bmatrix} 1 & 2 & -1: & 3 \\ 0 & 1 & -\frac{5}{7}: & \frac{8}{7} \\ 0 & -6 & 5: & -4 \end{bmatrix}$ By $R_2 \rightarrow (-\frac{1}{7})R_2$
 $\sim \begin{bmatrix} 1 & 2 & -1: & 3 \\ 0 & 1 & -\frac{5}{7}: & \frac{8}{7} \\ 0 & 0 & \frac{5}{7}: & \frac{20}{7} \end{bmatrix}$ By $R_3 \rightarrow R_3 + 6R_2$
 $\sim \begin{bmatrix} 1 & 2 & -1: & 3 \\ 0 & 1 & -\frac{5}{7}: & \frac{8}{7} \\ 0 & 0 & \frac{5}{7}: & \frac{20}{7} \end{bmatrix}$ By $R_3 \rightarrow (\frac{7}{5})R_3$

Here the coefficient matrix is in upper triangular form, so the system of linear equation can be written as

$$x + 2y - z = 3,$$
$$y - \frac{5}{7}z = \frac{8}{7}$$
$$z = 4$$

From third equation, we get z = 4, on substitution of value of z in second equation, we get y = 4, finally substituting the values of y & z in first equation, we get x = -1. Hence required solution is x = -1, y = 4, z = 4. This final step of obtaining the solution used in this method is called back substitution method.

2. Application in balancing the chemical equations:

In the study of chemistry, the students have to face various types of chemical reactions and each reaction is represented by a unique chemical equation. These chemical equations should be in balanced form. So being able to balance the chemical equations efficiently and correctly is vitally important for chemistry. Many students in introductory chemistry struggle with balancing chemical equations, because it requires multiple steps that are unique for each chemical equation. Linear algebra removes the differences and unites the process for all chemical equations. The traditional method like "hit and trail method" of balancing the chemical equations in general chemistry is just like a guessing game. So in linear algebra, we use the system of homogeneous linear equations and

and



row reduced echelon form of matrices to balance the chemical equations. The chemistry students of strong mathematical background can find this method easier. Consider a chemical equation, $C_3H_8+O_2\to CO_2+H_2O$

There are altogether four terms in the above chemical equation. So let us find the four whole numbers x_1, x_2, x_3, x_4 for each terms such that,

$$(x_1)C_3H_8 + (x_2)O_2 \rightarrow (x_3)CO_2 + (x_4)H_2O \quad \dots (1)$$

Then the total number of carbon (C), hydrogen (H) and oxygen (O) atoms on the left match the corresponding numbers on the right (because atoms are neither destroyed nor created in the reaction).

Let us set up the vector equation (or column vector) of each terms (compound or element) involved in the reaction.ie,

$$C_{3}H_{8} = \begin{bmatrix} 3\\ 8\\ 0 \end{bmatrix} \therefore \text{ There are 3 of carbon, 8 of hydrogen and 0 atoms of oxygen}$$

Similarly, $O_{2} = \begin{bmatrix} 0\\ 0\\ 2 \end{bmatrix}, CO_{2} = \begin{bmatrix} 1\\ 0\\ 2 \end{bmatrix} \text{ and } H_{2}O = \begin{bmatrix} 0\\ 2\\ 1 \end{bmatrix} \text{ Then putting in equation (1)}$
we get, $x_{1} \begin{bmatrix} 3\\ 8\\ 0 \end{bmatrix} + x_{2} \begin{bmatrix} 0\\ 0\\ 2 \end{bmatrix} = x_{3} \begin{bmatrix} 1\\ 0\\ 2 \end{bmatrix} + x_{4} \begin{bmatrix} 0\\ 2\\ 1 \end{bmatrix} \text{ (Here } \rightarrow \text{ is replaced by =)}$
or, $x_{1} \begin{bmatrix} 3\\ 8\\ 0 \end{bmatrix} + x_{2} \begin{bmatrix} 0\\ 0\\ 2 \end{bmatrix} - x_{3} \begin{bmatrix} 1\\ 0\\ 2 \end{bmatrix} - x_{4} \begin{bmatrix} 0\\ 2\\ 1 \end{bmatrix} = \begin{bmatrix} 0\\ 0\\ 0 \end{bmatrix}$

Similar

or,
$$x_1 \begin{bmatrix} 8\\0 \end{bmatrix} + x_2 \begin{bmatrix} 0\\2 \end{bmatrix} - x_3 \begin{bmatrix} 0\\2 \end{bmatrix} - x_4 \begin{bmatrix} 2\\1 \end{bmatrix} =$$

or, $\begin{bmatrix} 3x_1 + 0x_2 - 1x_3 - 0x_4\\8x_1 + 0x_2 - 0x_3 - 2x_4\\0x_1 + 2x_2 - 2x_3 - 1x_4 \end{bmatrix} = \begin{bmatrix} 0\\0\\0 \end{bmatrix}$

Now it becomes the system of homogeneous linear equations

$$3x_1 + 0x_2 - 1x_3 - 0x_4 = 0 8x_1 + 0x_2 - 0x_3 - 2x_4 = 0 0x_1 + 2x_2 - 2x_3 - 1x_4 = 0$$

The augmented matrix [A : C] is

$$\begin{bmatrix} 3 & 0 & -1 & 0: & 0 \\ 8 & 0 & 0 & -2: & 0 \\ 0 & 2 & -2 & -1: & 0 \end{bmatrix}$$

$$\sim \begin{bmatrix} 1 & 0 & -\frac{1}{3} & 0: & 0 \\ 8 & 0 & 0 & -2: & 0 \\ 0 & 2 & -2 & -1: & 0 \end{bmatrix} By R_1 \rightarrow \frac{1}{3}R_1$$

$$\sim \begin{bmatrix} 1 & 0 & -\frac{1}{3} & 0: & 0 \\ 0 & 2 & -2 & -1: & 0 \\ 8 & 0 & 0 & -2: & 0 \end{bmatrix} By R_2 \leftrightarrow R_3$$

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$$\sim \begin{bmatrix} 1 & 0 & -\frac{1}{3} & 0 : & 0 \\ 0 & 2 & -2 & -1 : & 0 \\ 0 & 0 & \frac{8}{3} & -2 : & 0 \end{bmatrix} By R_3 \rightarrow R_3 - 8R_1 \\ \sim \begin{bmatrix} 1 & 0 & -\frac{1}{3} & 0 : & 0 \\ 0 & 1 & -1 & -\frac{1}{2} : & 0 \\ 0 & 0 & \frac{8}{3} & -2 : & 0 \end{bmatrix} By R_2 \rightarrow \frac{1}{2}R_2 \\ \sim \begin{bmatrix} 1 & 0 & -\frac{1}{3} & 0 : & 0 \\ 0 & 1 & -1 & -\frac{1}{2} : & 0 \\ 0 & 0 & 1 & -\frac{3}{4} : & 0 \end{bmatrix} By R_3 \rightarrow \frac{3}{8}R_3$$

The above system is equivalent to the system of linear equations,

$$x_1 - \frac{1}{3}x_3 = 0,$$

 $x_2 - x_3 - \frac{1}{2}x_4 = 0,$
 $x_3 - \frac{3}{4}x_4 = 0$

From third equation of the system we get, $x_3 = \frac{3}{4}x_4$ (*Here* x_4 *is afree variable*.)

Using back substitution, from second equation we get

$$x_2 = x_3 + \frac{1}{2} x_4 = \frac{3}{4} x_4 + \frac{1}{2} x_4 = \frac{5}{4} x_4$$

Finally from first equation we get $x_1 = \frac{1}{3}x_3 = \frac{1}{3}\frac{3}{4}x_4 = \frac{1}{4}x_4$

Since the chemists prefer to use a balanced equation whose coefficients are the smallest possible whole numbers. So let us choose $x_4 = 4$ then we get

$$x_1 = 1$$
, $x_2 = 5$, $x_3 = 3$

Putting these values in equation (1) we get required balanced chemical equation

$$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$$

This method is helpful not only in simple equations; it is also helpful in solving some complicate types of equations. For example, consider the equation:

$$KMnO_{4} + MnSO_{4} + H_{2}O \to MnO_{2} + K_{2}SO_{4} + H_{2}SO_{4}$$

$$(x_{1})KMnO_{4} + (x_{2})MnSO_{4} + (x_{3})H_{2}O \to (x_{4})MnO_{2} + (x_{5})K_{2}SO_{4} + (x_{6})H_{2}SO_{4} \quad \dots (1)$$

$$KMnO_{4} = \begin{bmatrix} 1\\1\\4\\0\\0\end{bmatrix}, MnSO_{4} = \begin{bmatrix} 0\\1\\4\\1\\0\end{bmatrix}, H_{2}O = \begin{bmatrix} 0\\0\\1\\0\\2\end{bmatrix}, MnO_{2} = \begin{bmatrix} 0\\1\\2\\0\\0\end{bmatrix}, K_{2}SO_{4} = \begin{bmatrix} 2\\0\\4\\1\\0\end{bmatrix}, SO_{4} = \begin{bmatrix} 0\\0\\4\\1\\0\end{bmatrix}$$

Putting in equation (1), we get

$$x_{1} \begin{bmatrix} 1\\1\\4\\0\\0 \end{bmatrix} + x_{2} \begin{bmatrix} 0\\1\\4\\1\\0 \end{bmatrix} + x_{3} \begin{bmatrix} 0\\0\\1\\0\\2 \end{bmatrix} = x_{4} \begin{bmatrix} 0\\1\\2\\0\\0 \end{bmatrix} + x_{5} \begin{bmatrix} 2\\0\\4\\1\\0 \end{bmatrix} + x_{6} \begin{bmatrix} 0\\0\\4\\1\\0 \end{bmatrix}$$

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$$x_{1} \begin{bmatrix} 1\\1\\4\\0\\0 \end{bmatrix} + x_{2} \begin{bmatrix} 0\\1\\4\\1\\0 \end{bmatrix} + x_{3} \begin{bmatrix} 0\\0\\1\\0\\2 \end{bmatrix} - x_{4} \begin{bmatrix} 0\\1\\2\\0\\0 \end{bmatrix} - x_{5} \begin{bmatrix} 2\\0\\4\\1\\0 \end{bmatrix} - x_{6} \begin{bmatrix} 0\\0\\4\\1\\0 \end{bmatrix} = \begin{bmatrix} 0\\0\\0\\0\\0 \end{bmatrix}$$

The augmented matrix [*A*: *C*] is,

$$\sim \begin{bmatrix} 1 & 0 & 0 & 0 & -2 & 0 : 0 \\ 1 & 1 & 0 & -1 & 0 & 0 : 0 \\ 4 & 4 & 1 & -2 & -4 & -4 : 0 \\ 0 & 1 & 0 & 0 & -1 & -1 : 0 \\ 0 & 0 & 2 & 0 & 0 & -2 : 0 \end{bmatrix}$$

$$\sim \begin{bmatrix} 1 & 0 & 0 & 0 & -1 & 2 & 0 : 0 \\ 0 & 1 & 0 & -1 & 2 & 0 : 0 \\ 0 & 4 & 1 & -2 & 4 & -4 : 0 \\ 0 & 1 & 0 & 0 & -1 & -1 : 0 \\ 0 & 0 & 2 & 0 & 0 & -2 : 0 \end{bmatrix}$$

$$By R_1 \rightarrow R_2 - R_1, R_3 \rightarrow R_3 - 4R_1 \\ \sim \begin{bmatrix} 1 & 0 & 0 & 0 & -2 & 0 : 0 \\ 0 & 1 & 0 & -1 & 2 & 0 : 0 \\ 0 & 0 & 1 & 2 & -4 & -4 : 0 \\ 0 & 0 & 1 & 2 & -4 & -4 : 0 \\ 0 & 0 & 0 & 1 & -3 & -1 : 0 \\ 0 & 0 & 0 & 1 & -3 & -1 : 0 \\ 0 & 0 & 0 & 1 & 2 & -4 & -4 : 0 \\ 0 & 0 & 0 & 1 & 2 & -4 & -4 : 0 \\ 0 & 0 & 0 & 1 & -3 & -1 : 0 \\ 0 & 0 & 0 & -1 & 2 & 0 : 0 \\ 0 & 0 & 0 & -1 & 2 & 0 : 0 \\ 0 & 0 & 0 & -4 & 8 & 6 : 0 \end{bmatrix}$$

$$By R_5 \rightarrow R_5 - 2R_3 \\ \sim \begin{bmatrix} 1 & 0 & 0 & 0 & -2 & 0 : 0 \\ 0 & 1 & 0 & -1 & 2 & 0 : 0 \\ 0 & 0 & 0 & -4 & 8 & 6 : 0 \\ \end{bmatrix} By R_5 \rightarrow R_5 + 4R_4 \\ \sim \begin{bmatrix} 1 & 0 & 0 & 0 & -2 & 0 : 0 \\ 0 & 0 & 0 & -4 & 2 : 0 \\ 0 & 0 & 0 & -4 & 2 : 0 \end{bmatrix}$$

$$PR_5 \rightarrow R_5 + 4R_4 \\ \sim \begin{bmatrix} 1 & 0 & 0 & 0 & -2 & 0 : 0 \\ 0 & 0 & 0 & -4 & 2 : 0 \\ 0 & 0 & 0 & -1 & -3 & -1 : 0 \\ 0 & 0 & 0 & 0 & -4 & 2 : 0 \end{bmatrix}$$

$$By R_5 \rightarrow R_5 + 4R_4 \\ \sim \begin{bmatrix} 1 & 0 & 0 & 0 & -2 & 0 : 0 \\ 0 & 1 & 0 & -1 & 2 & 0 : 0 \\ 0 & 1 & 0 & -1 & 2 & 0 : 0 \\ 0 & 0 & 0 & 0 & -4 & 2 : 0 \end{bmatrix}$$

$$By R_5 \rightarrow (\frac{-1}{4})R_5$$

The above system is equivalent to the following system of linear equation,

 $x_1 - 2x_5 = 0$ $x_2 - x_4 + 2x_5 = 0$ $x_3 + 2x_4 - 4x_5 - 4x_6 = 0$ $x_4 - 3x_5 - x_6 = 0$ $x_5 - \frac{1}{2}x_6 = 0$



From fifth equation $x_5 = \frac{1}{2}x_6$, $x_4 = \frac{5}{2}x_6$, $x_3 = x_6$, $x_2 = \frac{3}{2}x_6$ and $x_1 = x_6$

Here, x_6 is a free variable. Since the chemists prefer to use a balanced equation whose coefficients are the smallest possible whole numbers. So let us choose $x_6 = 2$ then we get $x_1 = 2$, $x_2 = 3$, $x_3 = 2$, $x_4 = 5$, $x_5 = 1$

Now putting these values in equation (1) the required balanced equation is

 $2KMnO_4 + 3MnSO_4 + 2H_2O \rightarrow 5MnO_2 + K_2SO_4 + 2H_2SO_4$

3. Summary of the process:

The brief summary of the process is given below

- 1. Choose whole numbers $x_1, x_2, x_3 \dots \dots$ as many as number of terms involved in given chemical equation.
- 2. Write the given equation in terms of coefficients $x_1, x_2, x_3 \dots \dots$ just like $(x_1)C_3H_8 + (x_2)O_2 \rightarrow (x_3)CO_2 + (x_4)H_2O$.
- 3. Write the vector equation (column vector) of each terms (compound or element) involved in given equation for example $C_3 H_8 = \begin{bmatrix} 3\\8\\0 \end{bmatrix}$.
- 4. Put the column vector of each term in the original equation with coefficients $x_1, x_2, x_3 \dots \dots$ and then, get the system of homogeneous linear equation.
- 5. Find the augmented matrix [*A*: *C*] of the system of homogeneous linear equation.
- 6. Reduce the augmented matrix [*A*: *C*] to upper triangular form by row reduction algorithm.
- 7. Find the free variable and then, using back substitution method, find the values of whole numbers $x_1, x_2, x_3 \dots \dots$
- 8. Finally, substitute the values of $x_1, x_2, x_3 \dots \dots$ in the equation in which $x_1, x_2, x_3 \dots \dots$ are the coefficients.

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Finding Roots of Non-Linear Equation : A Comparative Study



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Abstract :-

The study is aimed at comparing the rate of performance, i.e. the rate of convergence of Bisection method, Newton-Raphson method and the Secant method of root-finding. The root of the function, f(x)=x-cosx on a close interval [0,1] is found using the Bisection method, the Newton's method and the Secant method and the result compared. It was observed that the Bisection method converges at the 52 second iteration while Newton and Secant methods converge to the exact root of 0.739085 with error 0.0000001 at the 8th and 6th iteration respectively. It was then concluded that of the three methods considered, Secant method is the most effective scheme. This is in line with the result.

Keywords: - Convergence, Roots, Algorithm, Iterations, Bisection method, Newton-Raphson method, Secant method and function

1. Introduction

1.1 Background of the study

A general history of numerical analysis up to 1900. Many researches focused attention towards using such method to solve their problems.

C. Thinzar and N. Aye made use of the digital image correlation that is based on the accuracy with the aid of Newton's-Raphson Method to detect storm direction for mapping and to prevent the possible land's attacked region. D-Biole used secant method in addition to other technique to messier apparent contact angles of non- axisymmetric drops. Md. G.Moazzam used a rabust method for solving transcendental equation. The presented method by them gave better results rather than well-known false position method and Bisection method for solving non-linear algebraic equations.

An expression of the form $f(X) = a_0 X^n + a_1 X^{n-1} + \dots + a_{n-1} X + a_n$ where a's are constant $(a_0 \neq 0)$ and n is positive integer, is called a polynomial of degree n in x. If f(x) contains some other function as trigonometric, logarithmic, exponential etc. then, f(x) is called transcendental equation. The value α of x which satisfies $f(\alpha) = 0$ is called a root of f(X) = 0, and a process to find out root is known as root finding process. Geometrically a root is the value of f(x) where the graph of y=f(x) crosses the x-axis.

The root finding problem is one of the most relevant computational problem. It arises in a wide verity of practical applications in physics, Chemistry, Biosciences, Engineering etc. As a matter of fact, the determination of any unknown appearing implicitly in scientific or Engineering formula gives rise to root finding problem. Relevant situation in physics where such problems are needed to be solved include finding the equilibrium position of an object, potential surface of a field and quantize energy

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level of confined structure. The common root finding methods include Bisection, Newton-Raphsons, False position, Secant methods etc. Different methods converges to the root at different rates. That is, some methods are faster in converging to the root then other. The rate of convergence could be linear, quadratic. Otherwise, higher the order the faster the method converges. The study is at comparing the rate of performance (convergence) of Bisection, Newton. Raphsons, and secant methods of root finding.

Obviously Newton- Raphsons method may converge faster than any other method but when we compare performance, it is needful to consider both cost and speed of convergence. An algorithm that converges quickly but takes a few seconds per iteration may take more time overall then an algorithm that converges more slowly, but takes only few milliseconds per iteration secant method requires only one function evaluation per iteration, since the value of (X_{n-1}) can be stored from pervious iteration. Newton-Raphsons method on the other hand, requires one functions and the derivative evaluation per it is often difficult to estimate the cost of evaluation the derivative in general (if possible). It seems safe, to assume that in most of cases, evaluating the derivative is at least as costly as evaluating the function. Thus we can estimate that the Newton's iteration takes about two functions evaluation per iteration. This disparity in cost means that we can run two iteration of the secant method in the same time it will take to run one iteration of Newton-Raphsos method. In comparing the rate of convergence of Bisection, Newton-Raphsons, Secant methods, used C⁺⁺ programming language to calculate the cube root of numbers from 1 to 25, using the three methods. We observed that the rate of convergence in the following order: Bisection method < Newton-Raphsons method.

1.2 Importance of Numerical Methods

Numerical computation plays a very important role in solving real life mathematical, physical and engineering problems. The development of digital computer has enhanced the speed and accuracy of numerical computation.

In the field of science and engineering complex mathematical problems are solved using the methods and algorithm of numerical methods. This has helped in both in the field of tackle the complex numerical methods. This has helped in both in the field of tackle the complex numerical in a more relevant and accurate way to obtain the desired solution.

The numerical methods involves the large numbers of calculation, which includes the iterative methods. Hence use to such algorithm in science and engineering provide greater accuracy.

Before the invention of computer, the calculation of such complex numerical was very difficult, but the numerical, so on the whole the numerical method has provided a great help to the field of science and engineering.

1.3 Terminology

i) Initial approximation

To begin with, we have some kind of initial guess for the root in practice, this may be done by drawing the graph of the equation. i.e. we simply plot the equation and make a rough estimate of the solution. analytically. We can usually choose any point in an internal where a change of sign takes place. However, this is subject to certain conditions that vary from method to method.



ii) Convergence:-

A numerical method of solving equations is generally a long process. We often have to know that whether the method we choose will lead to a solution or will lead us away from solution, if the method leads to a solution, we say that the method is convergent. Otherwise, the method is said to be divergent.

iii) Rate of convergence

How fast or how slow a convergence to a root occurs often depends upon the method we employ some computational methods are slow and take a long time in arriving at a root, while other methods can leads us to the root at a faster rate. In general, a compromise between case of calculation and time is often necessary and it is usually a matter of choice.

For a computer program however, it is generally better to look at methods which converges quickly. The rage of convergence could be linear or of some higher order. The higher the order, the faster the method converges. If e_i is the magnitude or the error in the ith iteration, ignoring sign, then its order is said to be n if $\frac{e_i+i}{e_in}$ is approximately constant it is also important to note that the choose method will converge only if $e_i + 1 < e_i$

1.4 Objective

The objective of the study are,

- 1. To find the solution of non linear equation.
- 2. To compare the method of solving non-linear equations.
- 3. To show solution in graph.

2. Different method of root finding

2.1 Bisection method

The bisection method based on the theorem which states that "Let f be a real valued and continuous function on a compact interval [a, b] in **R** and suppose that f(a) and f(b) have opposite signs i.e. f(a).f(b) < 0. Then there exist at least one point $c \in (a,b)$ such that f(c) = 0."



Figure1: Illustration of bisection

The graph of continuous function y = f(x) is shown in the figure.





The graph of y = f(x) lies above the x-axis at x = a and below x- axis at x = b. Bolzano's theorem asserts that the graph must cross the axis somewhere in between a and b. This property was first published by Bolzano in 1817.

The bisection method is one of the simplest methods for the solution of non-linear equations. This method is also known as half-interval method. Let f(x) = 0 is continuous on (a, b) and f(a) f(b) < 0. In order to find a root of f(x) = 0 lying in the interval (a, b). We shall determine a very small interval (a_0, b_0) in which $f(a_0) f(b_0) < 0$.

If there is only one real root of the equation f(x) = 0, in (a_0, b_0) , then there exist the following conditions:

- (1) If $f(x_1) = 0$, we have a root at x_1
- (2) If $f(x_1)f(a_0) < 0$, there is a root between x_1 and a_0 .
- (3) If $f(x_1) f(b_0) < 0$, there is a root between x_1 and b_0 .

when
$$x_1 = \frac{a_0 + b_0}{2}$$

We rename the interval in which the root lies as (a_1, b_1) so that

$$b_1 - a_1 = \frac{1}{2} (b_0 - a_0)$$

Now, $x_2 = \frac{a_1 + b_1}{2}$

 $f(x_2)f(a_1) < 0$ or $f(x_2)f(b_1) < 0$. We rename the interval as (a_2, b_2) i.e. (x_2, b_1) is re-named as (a_2, b_2) where b_2 - $a_2 = \frac{1}{2^2}$ (b_0 - a_0). Proceeding in this manner b_n - $a_n = \frac{1}{2^n}(b_0-a_0)$. Which gives us the (n+1)th approximation of the root of f(x) = 0 and the root lies in (a_n, b_n)

When to terminate Bisection method:

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The nth interval in bisection method is given by $b_n-a_n = 1/2^n(b_0-a_0)$ which gives us the $(n+1)^{th}$ approximation of the rout of f(x) = 0.

We can stop the process of bisecting the interval if any one of the following conditions meet.



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I) Advantages of Bisection method:

- a) This method is always convergent
- b) In this method we bisect the interval and get another interval. In this process some error occurs which is tolerable.

II) Draw backs of Bisection method:

a) This is slow method. Large number of iterations needed to reach the root.

 $f(x) = x^2$, $f(x) = \frac{1}{\chi}$. They do not have roots but changes signs.

b) This method cannot be applied for those function which just touches x-axis.

For example.



Figure 3: Draw Back of Bisection method



2.2 Algorithm of Bisection method

- 1) Define function f(x) and error E.
- 2) Take two initial value for root as x_1 and x_2 .
- 3) Computer $f(x_1)$ and $f(x_2)$
- 4) if $f(x_1) \times f(x_2) > 0$, then x_1 and x_2 do not converges and root does not lies in between x_1 and x_2 and go to step (9): otherwise.
- 5) If $f(x_1)f(x_2)<0$ when set $a = x_1$ and $b = x_2$ Else, set $a = x_2$ and $b = x_1$
- 6) Calculate root, $x_n = \frac{a+b}{2}$ and also calculate f (x_n)
- 7) if $f(x_1)f(x_n) < 0$ then, Set $b = x_n$ Also, set $a = x_1$
- 8) Repeat till step (7), until absolute value of $\frac{b-a}{n}$ is less than \in , then point root Root = $(\frac{a+x_n}{2})$, go to step (9), else to step (6).
- 9) Stop





2.3 Convergence of Bisection Method

Here, x_0 is the mid-point of x_1 and x_2 so depending upon the sign of $f(x_1)$ and $f(x_2)$, x_1 or x_2 is set equal to x_0 .

i.e. $f(x_0) \times f(x_1) < 0 \rightarrow x_2 = x_0$

 $f(x_0) \times f(x_2) < 0 \rightarrow x_1 = x_0$

If n is the number of iteration then,

$$\frac{x_2 - x_1}{2^n} = \frac{\Delta_x}{2^n} = \epsilon_n$$

Which is the error at n^{th} iteration.

The error decreases linearly with each state by factor 1/2. Therefore the bisection method is linearly convergent. The convergence is slow to achieve high degree of accuracy and large number of iteration may be required.

Example 1.

Consider the continuous function $f(x) = x^3 + x - 1$

- a) Evaluate f(0).
- b) Evaluate f(1)
- c) Determine the sign of f(0) f(1)
- d) We draw conclusion from (c)
- e) Use the bisection method to obtain the root of y = f(x) to four decimal places.

Solution to example 1,

- a) f(0) = -1.
- b) f(1) = 1
- c) $f(0) f(1) = (-1) \times (1) = -1 < 0$ i.e. The sign of f(0) f(1) is negative.
- d) $0 < x_{root} < 1$.
- e)

| S.N. | a | b | $\left(\frac{a+b}{2}\right)$ | f(a) | f(b) | $f\left(\frac{a+b}{2}\right)$ |
|------|-----|---|------------------------------|--------|------|-------------------------------|
| 1 | 0 | 1 | 0.5 | -1 | 1 | -0.375 |
| 2 | 0.5 | 1 | 0.75 | -0.375 | 1 | 0.1719 |



| S.N. | а | b | $\left(\frac{a+b}{2}\right)$ | f(a) | f(b) | $f\left(\frac{a+b}{2}\right)$ |
|------|--------|--------|------------------------------|---------|--------|-------------------------------|
| 3 | 0.5 | 0.75 | 0.625 | -0.375 | 0.1719 | -0.1309 |
| 4 | 0.625 | 0.75 | 0.6875 | -0.1309 | 0.1719 | 0.0125 |
| 5 | 0.625 | 0.6875 | 0.6563 | -0.1309 | 0.0125 | -0.610 |
| 6 | 0.6563 | 0.6875 | 0.6719 | -0.610 | 0.0125 | -0.0248 |
| 7 | 0.6719 | 0.6875 | 0.6797 | -0.0248 | 0.0125 | -0.0063 |
| 8 | 0.6719 | 0.6875 | 0.6836 | 0.0063 | 0.0125 | 0.0031 |
| 9 | 0.6817 | 0.6836 | 0.6817 | -0.0063 | 0.0031 | -0.0015 |
| 10 | 0.6817 | 0.6827 | 0.6827 | -0.0015 | 0.0031 | 0.0009 |
| 11 | 0.6822 | 0.6827 | 0.6822 | -0.0015 | 0.0009 | -0.0003 |
| 12 | 0.6822 | 0.6825 | 0.6825 | -0.003 | 0.0009 | 0.0004 |
| 13 | 0.6822 | 0.6824 | 0.6824 | -0.0003 | 0.0004 | 0.0002 |
| 14 | 0.6823 | 0.6824 | 0.6823 | -0.003 | 0.0002 | -0.0001 |
| 15 | 0.6823 | 0.6825 | 0.68335 | -0.0001 | 0.0002 | 0.0001 |
| 16 | 0.6823 | 0.6823 | 0.682333 | -0.0001 | 0.0001 | 0.00001 |

Table after 16 iterations, we can safely take x_{root} to be 0.6823 to four decimal places.

2.4 Newton-Raphsons method

One of the basic problems of mathematics is solving equations. Using quadratic root formula, we know how to find a point (solution) where $x^2 - 3x - 2 = 0$. There are more complicated formula to solve cubic or quadratic equations(polynomials of degree 3 or 4) but the Norwegian mathematician Niels-Abl showed no simple formula exist to solve equation like $f(x) = x^2 Sinx$, which involve transcendental functions as well as polynomials or other algebraic function.



Figure 5: Newton-Raphsons method



In this section, we study a numerical called Newton's method which is a technique to approximate the solution to an equation f(x) = 0. Essentially it uses tangent, lines in place of the graph of y = f(x) near the points where f is zero is a root of the function and a solution of the equation f(x) = 0.

Procedure for Newton's method :-

The goal of Newton's method for estimation a solution of an equation f(x) = 0 is to produce a sequence of approximation that approach the solution. We pick the first number x_0 of the sequence. Then under favorable circumstances, the method does the rest by moving step by step towards a point where the graph of f across the x- axis. At each step the method approximates a zero of f with a zero of one of its linearization.



Figure 6 : Procedure for Newton's method

Newton's method stands with the initial guess x_0 and (under favorable circumstance).

Geometry of the successive steps of Newton's method from x_n we go to the curve and follow the tangent line down to the x_{n+1} .

The initial estimate, x_0 , may be found by graphing for just plain guessing. The method then uses the tangent to the curve y = f(x) at $(x_0, f(x_0))$ to approximate the curve calling the point x_1 where the tangent meets the x-axis. The number x_1 is usually a better approximation to the solution than x_0 . The point x_2 where the tangent to the curve at $(x_1, f(x_1))$ crosses the x-axis is the next approximation in the sequence. We continue on, using each approximation to generate the next, until we are close enough to the root to stop.



Derivation of Newton's - Raphson Method :

We can derive a formula for generating the successive approximations in following ways. Given the approximation x_n , the point- slope equation for the tangent to the curve at $((x_n, f(x_n)))$ is,

$$y - f(x_n) = m(x-x_n)$$
$$y - f(x_n) = f'(x_n)(x-x_n)$$

We can find a point on x-axis by putting y=0 on it.

$$0-f(x_n) = f'(x_n)((x-x_n))$$
$$\frac{-f(x_n)}{f'(x_n)} = x-x_n$$
$$x = x_n - \frac{f(x_n)}{f'(x_n)}$$

Therefore we can write

This value of **x** in the next approximation x_{n+1} .

$$x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)}$$

We use the first approximation to get a second, the second to get the third and so on by using this formula taking n = 0,1,2,3....





2.5 Algorithm of Newton- Raphsons method

- 1. Assign an initial value of $x \text{ say } x_{0.}$
- 2. Evaluate $f(x_0)$ and $f'(x_0)$.
- 3. Find the improve estimation of x_0 $x_1 = x_0 - \frac{f(x_0)}{f^1(x_0)}$
- 4. check for accuracy of the listed estimate.
- 5. Compare relative error to the predefined value \in . if $\left|\frac{x_1-x_0}{x_1}\right| \leq \in$ stop; otherwise continue.
- 6. Replace x_0 by x_1 and repeat 3,4 and 5

i) Advantages and disadvantage

- The error decreases rapidly with each iteration.
- Newton's method is very fast(comparing with bisection method)
- Unfortunately for bad choice of x₀(the initial guess) the method can fail to converge, therefore the choice of x₀ is very important .
- Each iteration of Newton's method requires function evaluations, while the bisection method
 requires only one.

2.6 Convergence of Newton- Raphson Method:

Let, x_n be an estimate of the root of the function f(x). If x_n and x_{n+1} are close to each other, then using Taylor's series expansion, we can state;

Where 'R' lie somewhere in the interval x_n to x_{n+1} and third and higher order have been dropped.

Let us assume that the exact root of f(x) is x_r then $x_{n+1} = x_r$.

Therefore, $f(x_{n+1}) = 0$ and substituting the value in (1). We get

We know that the Newton's iterative formula is given by,

$$x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)}$$

Rearranging the terms we get

 $f(x_n) = f'(x_n) (x_{n+1} - x_n)$

Substituting this for $f(x_n)$ in equⁿ (2), yields;

$$0 = f'(x_n) (x_{n+1} - x_n) + \frac{f''(R)}{2} (x_{n+1} - x_n)^2 \dots (3)$$

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We know the error in the estimate x_{n+1} is given by;

 $e_{n+1} = x_n - x_{n+1}$

Now, equⁿ (3) can be expressed in terms of these errors as;

$$0 = f'(x_n) e_{n+1} + \frac{f''(R)}{2} (e_{n+1})^2$$

$$0 = f'(x_n) e_{n+1} + \frac{f''(R)}{2} (e_{n+1})^2$$

$$0 = f'(x_n) e_{n+1} + \frac{f''(R)}{2} \cdot \left(\frac{1}{2}e_n\right)^2$$

$$0 = f'(x_n) e_{n+1} + \frac{f''(R)}{2} \cdot \frac{e_n^2}{4}$$

$$e_{n+1} = -\frac{f''(R)e_n^2}{8f'(x_n)}$$

Rearranging the terms; we get,

$$e_{n+1} = -\frac{f''(R)}{8f''(x_n)}e_{2n}$$
(4)

This equation (4) show that the error is roughly proportional to the square of the error in the previous iteration. Therefore' the Newton- Raphson Method is said to have quadratic convergence.

Example :

Find the cube root of 3, correct upto 3 decimal places using Newton-Raphson Method.

Solution :

Let,
$$f(x) = x^3 - 3$$

 $f'(x) = 3x^2$

Let, the initial guess be 2.5.

So from Newton -Raphson Method ;

$$x_n = x_i - \frac{f(x_i)}{f'(x_i)}$$

| n | x_i | $f(x_i)$ | $f'(x_i)$ | $xn = x_i - \frac{f(x_i)}{f'(x_i)}$ |
|---|---------|-------------------------|-----------|-------------------------------------|
| 1 | 2.5 | 14.375 | 18.75 | 3.2667 |
| 2 | 3.2667 | 4.8600 | 32.0139 | 3.11489 |
| 3 | 3.11489 | 0.22234 | 29.1076 | 3.10725 |
| 4 | 3.10725 | 5.0671×10 ⁻⁴ | 28.965 | 3.10725 |

∴ Root = 3.107



2.7 Secant method

Secant method is like false position and bisection method; it uses two initial estimations but does not require that they must bracket the root. Let us consider the following figure.

In numerical analysis. The secant method is a root- finding algorithm that uses a succession of roots of secant lines to better approximate a root of a function f. The secant method can be thought of as a finite- difference approximation of Newton's method. However, the method was developed independently of Newton's method and predates it by over 3000 years

The secant method is defined by the recurrence relation.

$$x_n = x_{n-1} - f(x_{n-1}) \frac{(x_{n-1} - x_{n-2})}{f(x_{n-1}) - f(x_{n-2})} = \frac{x_{n-2}f(x_{n-1}) - x_{n-1}f(x_{n-2})}{f(x_{n-1}) - f(x_{n-2})}$$

As can be seen from the reoccurrence relation, the secant method required two initial values, x_0 and x_1 which should ideally be chosen to lie close to the root.



Figure 8 : Illustration of Secant method.

Derivation of the method

Starting with initial values x_0 and x_1 , we construct a line through the points $(x_0, f(x_0))$, as demonstrated in the picture above. in slope - intercept from this line has the equation.

$$y = \frac{f(x_1) - f(x_0)}{x_1 - x_0} (x - x_1) + f(x_1)$$

We find the root of this line- the value of x such that y=0 - by solving the following equation for x:

$$0 = \frac{f(x_1) - f(x_0)}{x_1 - x_0} (x - x_1) + f(x_1)$$

The solution is

$$x = x_1 - f(x_1) \frac{x_1 - x_0}{f(x_1) - f(x_0)}$$

We then use this new value of x as x_2 and repeat the process, using x_1 and x_2 instead of x_0 and x_1 .



We continue this process, solving for x_3 , x_4 etc. Until we reach a sufficiently high level of precision (a sufficiently small difference between x_n and x_{n-1})

$$x_{2} = x_{1} - f(x_{1}) \frac{x_{1} - x_{0}}{f(x_{1}) - f(x_{0})}$$

$$x_{3} = x_{2} - f(x_{2}) \frac{x_{2} - x_{1}}{f(x_{2}) - f(x_{1})}$$

$$\therefore \quad x_{n} = x_{n-1} - f(x_{n-1}) \frac{x_{n-1} - x_{n-2}}{f(x_{n-1}) - f(x_{n-2})}$$

2.8 Algorithm of secant method

- 1) Define function f(x) and error \in .
- 2) Take two initial guess of interval for root as x_1 and x_2
- 3) Calculate $f(x_1)$ and $f(x_2)$
- 4) If $f(x_1)f(x_2)>0$ then root does not lie in between x_1 and x_2 , so go step 8.
- 5) If $f(x_1)f(x_2) < 0$ then set $a=x_1$ and $b=x_2$
- 6) Calculate root by $x_n = \frac{af(b) bf(a)}{f(b) f(a)}$ and x_n
- 7) If $\left(\frac{(b-a)}{b}\right) \le then point root is x_n$ Also, go to step 5
- 8) Stop.

i) Advantages of secant method:

- Better- than- linear convergence near simple root
- Linear convergence near multiple root.
- No derivative needed.

ii) Disadvantages

- Iterates may diverge
- No practical & rigorous error bound

Example:

To find an approximate root of $x \log x - 1.2 = 0$ using secant method up to three decimal place of accuracy.

Solution:

Given that, $f(x) = x \log_{10} - 1.2$ let, the initial guess be 2 and 3 $\therefore \qquad f(2) = -0.597 < 0$ and, f(3) = 0.2313 > 0Therefore the root lies in betⁿ 2 and 3 where, a = 2 and b = 3 error = 0.0001 By secant method ; we have, $x_n = \frac{a f(b) - b f(a)}{f(b) - f(a)}$

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| n | а | b | f(a) | f(b) | x _n |
|---|--------|--------|----------|------------|----------------|
| 1 | 2 | 3 | 0.59 | 6.2313 | 2.7207 |
| 2 | 3 | 2.7207 | +0.2313 | -0.01736 | 2.7401 |
| 3 | 2.7207 | 2.7401 | -0.01736 | -0.000 47< | 2.7401 |

Now let us use tabular form for the calculation of root.

The 2nd and 3rd iteration has similar value of x_n up to 3 decimal place, so the root of equation f(x) equation $f(x) = x \log_{10} x$ -1.2 is 2.740.

3. Comparison, implementation and Discussion

3.1 Comparison:

The above three algorithms have all their weak and strong points, thus a comparison is asked for:

- Bisection method is guaranteed to converge to a solution
- The secant method converges faster than bisection or Regular falls, but the performance of Newton is hard to beat.
- The secant and Newton's method might not give the desired/ expected solution or might even fail completely.
- Only Newton Raphson method requires values of derivative.

| steps | а | Functional value | b | Functional value |
|-------|----------------|------------------|-----------------|------------------|
| 1 | 0 | -1 | 1 | 0.459698 |
| 2 | 0.5 | -0.377583 | 1 | 0.459698 |
| 3 | 0.5 | -0.377583 | 0.75 | 0.0183111 |
| 4 | 0.625 | -0.185963 | 0.75 | 0.0183111 |
| 5 | 0.6875 | -0.0853349 | 0.75 | 0.0183111 |
| 6 | 0.71875 | -0.0338794 | 0.75 | 0.0183111 |
| 7 | 0.734375 | -0.00787473 | 0.75 | 0.0183111 |
| 8 | 0.73828125 | -0.00787473 | 0.7421875 | 0.00519571 |
| 9 | 0.73828125 | -0.00134515 | 0.7421875 | 0.00519571 |
| 10 | 0.73828125 | -0.00134515 | 0.7392578125 | 0.00192387 |
| 11 | 0.73876953125 | -0.00134515 | 0.7392578125 | 0.000289009 |
| 12 | 0.739013671875 | -0.000528158 | 0.7392578125 | 0.000289009 |
| 13 | 0.739013671875 | -0.000119597 | 0.7391357421875 | 0.000289009 |

3.2 Iteration data for bisection method

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| steps | a | Functional value | b | Functional value |
|-------|--------------------|----------------------------|--------------------|---------------------------|
| 14 | 0.73907470703125 | -0.000119597 | 0.7391357421875 | 0.0000874007 |
| 15 | 0.73907470703125 | -0.0000174493 | 0.739105224609375 | 0.0000874007 |
| 16 | 0.73907470703125 | -0.0000174493 | 0.7390899658203125 | 0.0000336253 |
| 17 | 0.7390823364257813 | -0.0000174493 | 0.7390899658203125 | 8.0879×10 ⁻⁶ |
| 18 | 0.7390823364257813 | -4.6807×10-6 | 0.7390861511230469 | 8.0879×10 ⁻⁶ |
| 19 | 0.7390823364257813 | -4.6807×10-6 | 0.7390861511230469 | 1.7035×10 ⁻⁶ |
| 20 | 0.7390823364257813 | -1.48858×10-6 | 0.7390851974487305 | 1.7035×10-6 |
| 21 | 0.7390842437744141 | -6.90538×10-7 | 0.7390851974487305 | 1.07502×10-6 |
| 22 | 0.7390842437744141 | -2.91518×10-7 | 0.7390851974487305 | 1.07502×10-7 |
| 23 | 0.7390850782394409 | -9.2008×10 ⁻⁸ | 0.7390851974487305 | 1.07502×10-7 |
| 24 | 0.7390850782394409 | -9.2008×10 ⁻⁸ | 0.7390851378440857 | 1.07502×10-7 |
| 25 | 0.7390851080417633 | -4021305×10-8 | 0.7390851378440857 | 1.07502×10-7 |
| 26 | 0.7390851229429245 | -1.71917×10 ⁻⁸ | 0.7390851378440857 | 7.74702×10-9 |
| 27 | 0.7390851303935051 | -4.72236×10-9 | 0.7390851378440857 | 7.74702×10-9 |
| 28 | 0.7390851303935051 | -4.72236×10-9 | 0.7390851341187954 | 7.74702×10-9 |
| 29 | 0.7390851322561502 | -1.60501×10-9 | 0.7390851341187954 | 7.74702×10-9 |
| 30 | 0.7390851331874728 | -4.63387×10-11 | 0.7390851341187954 | 1.51233×10-9 |
| 31 | 0.7390851331874728 | -4.63387×10-11 | 0.7390851336531341 | 1.51233×10-9 |
| 32 | 0.7390851331874728 | -4.63387×10-11 | 0.7390851333038881 | 1.51233×10-9 |
| 33 | 0.7390851331874728 | -4.63387×10-11 | 0.7390851332456805 | 3.43329×10 ⁻¹⁰ |
| 34 | 0.7390851331874728 | -4.63387×10-11 | 0.7390851332165767 | 1.48495×10-10 |
| 35 | 0.7390851331874728 | -4.63387×10-11 | 0.7390851332165767 | 5.10784×10-11 |
| 36 | 0.7390851332020247 | -2.19844×10 ⁻¹¹ | 0.7390851332165767 | 2.36988×10 ⁻¹² |
| 37 | 0.7390851332093007 | -9.80727×10 ⁻¹² | 0.7390851332165767 | 2.36988×10 ⁻¹² |
| 38 | 0.7390851332129387 | -3.71869×10 ⁻¹² | 0.7390851332165767 | 2.36988×10-12 |
| 39 | 0.7390851332147577 | -6.7446×10 ⁻¹³ | 0.7390851332165767 | 2.36988×10 ⁻¹² |
| 40 | 0.7390851332147577 | -6.7446×10 ⁻¹³ | 0.7390851332156672 | 2.36988×10-12 |
| 41 | 0.7390851332147577 | -6.7446×10 ⁻¹³ | 0.7390851332152124 | 8.47655×10 ⁻¹³ |
| 42 | 0.7390851332149850 | -2.93876×10 ⁻¹³ | 0.7390851332152124 | 8.65974×10 ⁻¹⁴ |
| 43 | 0.7390851332150987 | -1.03584×10 ⁻¹³ | 0.7390851332152124 | 8.65974×10 ⁻¹⁴ |
| 44 | 0.7390851332151556 | -8.54872×10 ⁻¹⁵ | 0.7390851332152124 | 8.65974×10 ⁻¹⁴ |
| 45 | 0.7390851332151556 | -8.54872×10 ⁻¹⁵ | 0.7390851332151840 | 8.65974×10 ⁻¹⁴ |
| 46 | 0.7390851332151556 | -8.54872×10 ⁻¹⁵ | 0.7390851332151698 | 1.53211×10 ⁻¹⁴ |
| 47 | 0.7390851332151556 | -8.54872×10 ⁻¹⁵ | 0.7390851332151627 | 1.53211×10 ⁻¹⁴ |



| steps | a | Functional value | b | Functional value |
|-------|--------------------|----------------------------|--------------------|---------------------------|
| 48 | 0.7390851332151591 | -2.55351×10 ⁻¹⁵ | 0.7390851332151627 | 3.44196×10 ⁻¹⁵ |
| 49 | 0.7390851332151591 | -2.55351×10-15 | 0.7390851332151609 | 3.44196×10 ⁻¹⁵ |
| 50 | 0.7390851332151600 | -1.11022×10 ⁻¹⁵ | 0.7390851332151609 | 4.44089×10 ⁻¹⁵ |
| 51 | 0.7390851332151605 | -3.33067×10 ⁻¹⁶ | 0.7390851332151609 | 4.44089×10 ⁻¹⁵ |
| 52 | 0.7390851332151607 | 0 | 0.7390851332151607 | 4.44089×10-15 |

Table 1 shows the iteration data obtained for Bisection method. It was observed that in table 1 using the bisection method the function, $f(x) = x \cdot \cos x = 0$ at the interval [0,1] converges to 0.7390851332151607 at the 52 iteration.

| Steps | X _k | f(x _{k+1}) |
|-------|----------------|----------------------|
| 1 | 0.5 | -9.62711 |
| 2 | -9.62771 | -2.43009 |
| 3 | -2.43009 | 2.39002 |
| 4 | 2.39002 | 0.535581 |
| 5 | 0.535581 | 0.75.361 |
| 6 | 0750361 | 0.739113 |
| 7 | 0.739113 | 0.739085 |
| 8 | 0.739885 | 0.739085 |

3.4 Iteration data for Newton- Raphsons method with $x_0 = 0.5$

Table 2 revealed that with $x_0=0$, the function converges to 0.739085 with 8th iteration.

3.5 Iteration data for secant method

| x ₀ | 0 | |
|-----------------------|----------|--|
| x ₁ | 1 | |
| x ₂ | 0.685073 | |
| x ₃ | 0.736299 | |
| X4 | 0.739119 | |
| x 5 | 0.739085 | |
| x ₆ | 0.739085 | |
| x ₇ | 0.739085 | |

From table 3 we noticed that function converges to 0.739085 after the 6th iteration.

3.6 Discussion

Comparing the results of the three methods under investigation, we observed that the rates of convergence of the methods are in the following order: Secant method > Newton-Raphson method >



Bisection method. Comparing the Newton-Raphson method and the Secant method, we noticed that theoretically, Newton's method may converge faster than Secant method (order 2 as against α = 1.6 for Secant). However, Newton's method requires the evaluation of both the function f(x). Hence, Secant method may occasionally be faster in practice as in the case of our study. Above table, if we assume that evaluating f(x) takes as much time as evaluating its derivative, and we neglect all other costs, we can do two iteration of Secant (decreasing the logarithm of error by factor $\propto 2=2.6$) for the same cost as one iteration of Newton-Raphson method (decreasing the logarithm of error by a factor 2). So, on this premises also, we can claim that Secant method is faster than the Newton's method in terms of the rate of convergence.

Conclusion

Based on our results and discussions, we now conclude that the Secant method is formally the most effective of the methods we have considered here in the study. This is equal to the fact that it has a converging rate close to that of Newton-Raphson method, but requires only a single function evaluation per iteration. We also concluded that though the convergence of bisection is certain, its rate of convergence is too slow and as such it is quite difficult to extend to use for systems of equations.

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Applications and Challenges of Nanotechnology: Present scenario and Future perspectives



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Abstract

The nanostructure materials, devices and system by exploiting nanoscale material property in the nanotechnology have been associated with the significant contributions to human society and nanotechnology enhanced products with many more to come. Even though nanotechnology is in its infancy, it has been advancing at its useful applications in cosmetics, healthcares, textiles, tissue engineering, catalysis, sanitary wares, electronics, construction materials, functional coatings, automobiles, medical diagnosis and therapeutics, sensors and communication engineering, food industry, water and air pollution treatment. The comparative study and research on formation, structure, and characteristics associated with the nanomaterials concluded that the many nanomaterials are versatile in their application in various field. The present article provides some information regarding the nanomaterials, their potential uses in various arenas along with challenges and scope in developing country.

Keywords: Nanoscience, nano meter, top down approach, bottom up approach, carbon nanotubes, scanning tunneling microscope, nanomaterial characterization, digital nano processors, nano drug delivery, nanobiosensors, nanocatalyst, nanocomposite fibers, computing speed, miniaturization, nanoresearch, nano cargo, millipede memory, nano-toxicology, computational power, nano robots, general challenges, ethical challenges.

Introduction

Nanotechnology is the branch of technology that concentrates on creations of nanostructure materials, devices and system by exploiting nanoscale material property. Nanostructure materials are formed by assembly or repetition of nanometer sized building blocks. The term nanotechnology is employed to describe the creation and exploration of materials with structural features in between atom and bulk materials, at least one dimension in the nano meter range(1nm=10⁻⁹m) to the size 100nm. The first use of concept in 'nanotechnology' was in "there is plenty of room at the bottom", a often cited lecture presented by Richard Feynman at an American Physical Society meeting at

California Institute of Technology in December 29,1959.Feynman described a process by which the ability to manipulate individual atoms and molecules might be developed and how physical phenomena could change if the size of the material is continuously reduced from large to very small (nanometer). The term nanotechnology was coined by Norio Taniguchi in 1974. Nanotechnology mainly consists of the processing of separation, consolidation and deformation of materials by one atom or molecule. Nanotechnology and nanoscience get started in the early 1980's with two major developments such as the birth of cluster science and the invention of scanning tunneling microscope (STM).Nanotechnology was considered to be purely theoretical and concept came true only

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after the discovery of scanning tunneling microscope (STM) that allowed the discovery of fullerene (C_{60}) in 1986 and carbon nanotubes in 1991. Carbon nanotubes are proven to have unique electrical and optical properties. In another development, the synthesis and properties of semiconductor nanocrystals were studied. This led to development of metal oxide nanoparticle of quantum dots. After six year, the discovery of STM, atomic force microscope was invented. The US national nanotechnology initiative was founded to coordinate federal nanotechnology research and development in 2000.

Nanoparticles are synthesized either by reduction of sizes from a macro molecule (top down approach) or by assembling sub nanometer building blocks of the nanoscale materials (bottom up approach). Nanomaterials show unique mechanical, thermal, electrical, magnetic, diffusive, catalytic and optical properties as compared to its bulk counterpart. The origins of these unique properties in nanomaterials are due to nanoscopic size. The unique properties and function exhibited by nanomaterials over their counter bulk parts has direct relation to their physical properties like distribution and uniformity of size, inter-particle distance and atomic or electronic properties. After synthesizing nanomaterials by various routes, the finding of structure and function correlation is carried out by using one or more techniques (viz spectroscopic technique, X-ray diffraction and scattering, molecular technique and mechanical technique) this step in nanoresearch is called nanomaterial characterization.

Applications

Nanotechnology is finding application in virtually all fields ranging from science to engineering, influencing our lifestyle in many ways. The consumer world is being flooded with nanotechnology enhanced products with many more to come. Some of the important applications are summarized as:

i. Information and communication:

Nanotechnology has been shrinking the size

(miniaturization) of electronic devices by reducing size of transistors, capacitors, resistors, etc. It can be used in digital nano processors due to which minicomputer are recently developed. With the help of quantum mechanical effect (in which tunneling of electron between two conducting regions separated by thin insulator) the speed of electron conduction as well as processing speed of electronic devices could be increased. Today's multifunctional laptop, palmtop, mobile phone, pocket-sized memory device, MP3 player, iPod and ipad, novel semiconductor device, ICs, novel optoelectronic device (converts electricity to light and vice-versa such as LEDs:light emitting display,LCDs: liquid crystal display, VCD/DVD players etc) and quantum computers (perform several computation at same time and useful to solve specific problem) are convincing benefits of nanotechnology.

ii. Medicine:

In the field of medicine, nanotechnology finds application in diagnosis, therapeutics, biomedical applications including pharmaceuticals, medical imaging and diagnosis, cancer treatment, implantable materials, tissue engineering, etc. Nanotechnology is being developed for both therapeutic (using nano drug delivery) and diagnostic (nano-biosensors) applications. For examples, gold nanoparticle attached to short segment of DNA can be used to detect the genetic sequence of the sample, bandages embedded with silver nano particles are used as anti-microbial protection and to aid faster wound healing, Nanostructured synthetic skin is being used for skin graft applications, bio capsules are used as substituents for diabetic insulin, targeted drug delivery, biosensors(pregnancy test kit, glucose sensor), By using nano meter sized vaccines, nano meter sized virus or bacteria can be killed or even replaced from our body, so could be an important tool for treatment of AIDS.

iii. Chemical science and environment:

Nanotechnology plays important role in various chemical reaction, water treatment and

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environment clean up by developing nanoparticle and nanomaterials. Chemical catalysed reactions benefit largely from nanocatalyst, due to extremely large surface to volume ratio, large surface energy, larger number of active sites, ease of separation, surface unsaturated bonding, high density of surface defects like Frenkel and Schottky defects, vacancies, cation and anion corners etc. Gold nanoparticles, carbon nanostructures like carbon nanotubes, graphene, and carbon nanofibers are widely studied nanocatalyst. A nanocatalyst containing a few nanometer shell of iron oxide on the surface of titanium oxide core is useful to detoxify cigarette smoke by removing radicals, catechols, dioxins, carbon and toxic hydrocarbons from other combustion source. Another application of nanocatalysts is in biomass gasification and biomass pyrolysis for production of bio-oil. Application of nanomaterials in water treatment is focused on water quality control via development of sensitive analytical methods, water purification via generation of efficient nanomembrane and nanofiltration materials and waste water treatment via nano adsorbants, nanomembranes and nanocatalysts. The inorganic metal ion as impurities like As, Cd, Ag, Cu, Pb, Hg, Zn, Cr, etc., present in sample can be effectively removed by using metallic oxide nanoparticles like iron oxide, titanium oxide and aluminium oxide. Iron oxide nanoparticle adsorbs virus and bacteria efficiently. Recently carbon nanotubes have been used for the adsorption of various ions. Various type of nanofibers and porous membranes are designed for removing cysts and intero-parasites like giardia, entamoeba etc., from drinking water and efficient filtration of PM10 and noxious gases.

iv. Energy:

Nanotechnology could help with reduction of energy consumption via developing smart materials like LEDs, nanoball bearing lubricants, etc., enhancing storage capacity source like ultra capacitors, more environmentally friendly efficient energy system, zero loss energy transmission system and recycling of battery, etc. Carbon nanotubes could be the alternate electrical nanomaterial in place of conventional wiring, being much lighter, corrosion proof nanowires. Inorganic fullerenes like tungsten disulphide enhance the efficiency of lubricants behaving as nanoball bearing which reduce friction and energy wastage in automobiles and industrial machinery.

v. Consumer goods:

Nanotechnology could offer advantages to the foods, cosmetics, textiles, paints, and purification products etc, as consumer goods. Food poisoning and decaying due to degradation of packaging materials has been reduced by developing smart packaging nanomaterials which could repair holes and tears and also alert consumer for any possible contamination. The commonly used nanomaterials in personal care products are carbon nano particles, carbon black, silver, gold, TiO₂, SiO₂, ZnO, etc. Gold and silver find uses in personal care products due to their anti fungal, antibacterial properties. Fullerenes and gold nanoparticles are claimed to prevent premature aging of skin via increasing elasticity of skin, reducing wrinkles, etc. TiO, and ZnO is used in formulations of anti-UV sunscreens.

Nanotechnology finds its application in textile industry by offering advantage via reducing cost of production, increasing durability of fabrics, eco-friendliness, effective packing, hygienic properties, etc. Nanocomposite fibers containing nanosilicates, graphite nanofibers, metal oxide nanofibers are already been applied for automotive, military, aerospace applications as they posses water repellent, light emitting, antibacterial without affecting properties of fabrics. Nanomaterials like nanosilver, nanocopper, nanozincoxide and nanosilicondioxide find application in paint industry on the production of better paint formulation with biocidal properties and resistance to physical and chemical degradation.

vi. Heavy industry and others:

Nanotechnology finds its application in automobile/vehicle industry by improving the quality of different components like light weight

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fuel cell, batteries, wear resistant tyres, light but strong material, antibacterial coatings, scratch resistance and fully self repairing paints, UVresistance lubricants. Space programs could greatly benefit with the application of light weight but strong nanomterials based on carbon nanotubes and composite materials as they reduce energy requirement and cost of space program. By equipping tiny sensor devices in spacesuits helps spaceman in the detection of harmful radiation. Nano materials like metallic, ceramic, polymers and composite materials help in structure and construction application by developing durable, mechanically strong and enhance ductile material.

Challenges

Nanotechnology finds a variety of applications, ranging from toothpaste to satellites including industrial to large scale societal applications. With the hope that nanotechnology will discover many smart appliances and product in future, developed as well as developing countries are doing significant investment in this field. Along with the developments in nanotechnology several ethical and general challenges that we are facing as:

a. General challenges:

The investment on nanoresearch is negligible in most of developing countries like Nepal due to lack of enough human resource, laboratory equipments to carry related research, unable to convince policy level people about the scope of research, unable to establish separate material science department related to nanotechnology and engineering and related topics in academic syllabus. Thus, developing countries like Nepal could not do related activities without collaboration with international research group.

b. Ethical challenges:

Along with the advancement in nanotechnology, ethical, moral and societal issues will raise in future. The effect of nanomaterials on biological and ecological system including nano-toxicology is an ethical issue.

- i. The invention of molecular machine or nano cargo can stop aging process of living things by repairing and replacing damaged cell and tissues. It will raise societal and ethical issues if such invention is possible in future.
- ii. The dream of nanotechnology is to build nanorobots that can have human like intelligence finding wrong, right and correcting it. It will raise societal and ethical issues if such invention is possible in future and people misuse it.
- iii. Another dream of nanotechnology is to build nanoscopic camera invisible to our eye. It will raise societal and ethical issues if such invention is possible in future and it affects the privacy of an individual.
- iv. Nanotechnology will invent nanomaterials that can be used for weapons. It will raise ethical issues if such invention is possible in future and misused by ill intended people.
- v. The patenting of a discovery increases its market value but poor people could not afford such technology and product. There will be some ethical issues related to it.
- vi. If our environment is contaminated with nanomaterials, toxicological issues begin to appear in a specific live species which further impact the others through food chain.

Future Perspectives

Nanotechnology will contribute society and economy of developing country in so many ways. In future, nanotechnology can make significant contribution and improvement basically in the area of energy, health, data storage and computing speed etc.

* **Energy:** Nanotechnology will full fill the current energy demand by providing efficient and eco-friendly source of energy.

* *Health:* Nanotechnology is being developed for both therapeutic (using nano drug delivery) and diagnostic (nano-biosensors) applications. The designing of efficient molecular machine is to deliver drug to the cell in order to repair them.

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*Data storage: Nanotechnology is being developed for designing ultra high density data storage devices like millipede memory (an array of micro cantilevers to form nanoscopic indentations in a polymer).

* *Computing speed:* Nanotechnology can be used in digital nano processors due to which minicomputer are recently developed. With the help of quantum mechanical effect (in which tunneling of electron between two conducting regions separated by thin insulator) the speed of electron conduction as well as processing speed of electronic devices could be increased.

* *Miniaturization of electronic devices*: Nanotechnology has been shrinking the size (miniaturization) of electronic devices by reducing size of transistors, capacitors, resistors, etc. This process increases the computational power and energy efficiency of these devices.

Nanotechnology finds a variety of applications including industrial to large scale societal applications. It has been finding potential use in homogeneous catalysis, energy, health, data storage and computing speed etc. The developed as well as developing countries are doing significant investment in this field hoping that nanotechnology will discover many smart appliances and product in future. Along with the developments in nanotechnology several ethical and general challenges has been noticed.

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Number System and It's Application

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Abstract :

This work is specially focused on the study and application of number system. It is starting from concept of natural numbers. Then to integers, rational and irrational and then to complex numbers. Examples and application of number systems are given, concept of number system are used widely in different applicable field.

The main aim of this project work is to develop clear concept of number system and its application in different field of Mathematics like solving certain equations in the system such linear, quadratic and other polynomial equation. Introduction of complex numbers enables us to solve all polynomial equations such as to solve all polynomial equations with real and no real solutions.

Key Words : Natural number, Integer, Rational number, Irrational number, Real number, Complex number, Absolute Value, Peano's Axioms, Field Axioms, Order Axioms, Archimediean Property, Rational Density Theorem, Extended Real Number System, Ponomial Equation, Complex Conjugate, Polar Form, Congruence.

1.1 Background

we look at some different systems of number, and the rules for combining number in these systems. For each system we consider the question of which elements have additive and multiplicative inverse in the system. We look at solving certain equations in the system, such as linear, quadratic and other polynomial equation. We start by revising the notation used for the rational numbers and the real numbers, and we list their arithmetical properties.

Then we introduce the set of complex numbers. The system of number enables us to solve all polynomial equations, including those with no real solution. We correspond complex numbers with the complex plane. We look further at some properties of the integers and introduce modular arithmetic inequalities.

1.2 History

Number system have progressed from the use of tally marks, more than 40,000 years ago, through the use of set of glyphs to efficiently represent any conceivable method. The first method of counting has been argued to be counting on fingers. This evolved into sign language for the hand to- eye- to-elbow communication of numbers, which, while not writing, gave way to written numbers. Tallies made by carving notches in wood bone and stone were used for at least forty thousand years. These tally marks may have been used for counting elapsed time, such as number of days, lunar cycles or keeping records of quantities, such as of animals. Lebombo bone is a baboon fibula with incised





marking discovered in the lebambo Mountains located between south Africa and Swaziland. The bone is between 44,230 and 43,000 years old. According to 'The Universal Book of mathematics the lebombo bones 29 nutches suggest' it may have been used as a lunar phase counter in which case African women may have been the first mathematics, because keeping track of menstrual cycles requires a lunar calendar.

The earliest known writing for record keeping evolved from a system of counting using small clay tokens. To create a record that represented "two sheep" they selected two round clay tokens each having a +ve sign backed into it. Each token represented one sheep. Representing a hundred sheep with a hundred tokens would be impractical, so they invented different clay tokens to represent different numbers of each specific commodity, and by 4000 Bc strung the tokens like beads on a string. There was a token like beads on a string. There was a token for one sheep, a different token for ten sheep, a different token for ten goats etc. Thirty-two sheep would be represented by three tensheep tokens followed on the string by two one-sheep tokens. Beginning about 3500Bc the tokens and envelops were replaced by numerical impressed with a round stylus at different angles in fact clay tablets which were taken baked. Abstract numerals, dissociated from the thing being counted, were invited about 3100 BC. The sumerians had a complex assortment of incompatible number systems, and each city had its own local way of writing numerals. For instance, at about 3100 BC in the city of uruk, there were more than a dozen different numeric systems. In this city, there were separate number system for counting discrete objects (such as animals, tools, and containers), cheese and grain, area and time and calender units. further more these system changed other time for instance numbers for counting volume of grains changed when the size of the baskets changed.

The sumerians invented arithmetic. People who added and subtracted volumes of grains every day used their arithmetic skills to count other things that were un-related to volume measurement multiplication and division were done with multiplication tables baked in clay tables. Between 2700 BC and 2000 BC, the round stylus were gradually replaced try a reed stylus cuneiform sings in clay. To represent numbers that previously had been pressed with a round stylus, these cuneiform number signs were pressed in a circular pattern and they retained the additive sign value notation that originated with tokens on a strings. Cuneiform numerals and archaic numerals were ambiguous because they represented various numeric systems that different depending on what was being counted.

About 1200 BC in Sumer, these proto sexagesimal sign-value system gradually converged on a common sexagesimal number system that was a place-value system consisting of only two impressed marks, which could also represent fractions. This sexagesimal number system was fully developed at the beginning of the old Babylonia period (about 1950 BC) and became standard in Babylonia.

Later by the requirement of counting various number system were discovered.

1.3 Objectives of Study

The main objectives are :

- 1. Explain the arithmetical properties of the rational and real numbers.
- 2. Explain the definition of a complex numbers.
- 3. Compute arithmetical operations with complex numbers.
- 4. Explain the terms modular addition and modular multiplication
- 5. Explain the meaning of inequality.



2. Literature review

A strong sense of number and the quantity it represents in an integral part of all areas of life affecting successful functioning on the job, in school, at home and in the community. Despite the importance of quantitative reasoning mathematical difficulties are widespread among students.(Dougherty,2003; Ostad, 1998)

Knowledge about the structure of the number system is essential for students to perform computations in flexible and creative ways. White a robust sense of number is major component of the mathematical curriculum in elementary and middle school, number sense is also crucial for the development of later mathematical thinking. Nation (NCTM, 2000).

Number system entails knowledge of counting, number patterns magnitude comparisons, estimation, and number transformation (Berch, 2005)

Students with good number sense develop a quantitative intuition that helps them to solve problems in a flexible manner. They understand that numbers are representative of objects, magnitudes, relationships, and other attributes and are aware that number can be operated on, compared, and used for communication. National Research Council (2001)

There is emerging evidence that number sense is one of the most important skills necessary for success with basic mathematical computations in the early grades(Chard et al.2005; Gersten and chard,1999).With well- developed number sense knowledge, students can use flexible ways to make mathematical judgment and develop useful strategies for solving complex problems(NCTM, (2002)

3. Number System

In mathematical language you met the sets.

N={1, 2, 3, ... }, The natural numbers

Z= {.... -2, -1, 0, 1, 2, ...}, The integers

 $Q = \{ P/q ; P \in \mathbb{Z}, q \in \mathbb{N} \},$ the rational number

3.1 Natural numbers

The simplest and the most familiar understanding chain of consecutive numbers 1, 2, 3, ...,10, 11, 12, ..., 101, 102, 103, ... are known as the natural numbers. The natural numbers are also known as the counting numbers. The set of natural numbers are denoted by N.

 \therefore N = {1, 2, 3, ..., 10, 11, 12, ..., 101, 102, 103, ...}

Since the sum and the product of two natural numbers are again natural numbers, so natural numbers are said to be closed under the operation of addition and multiplication.

For e.g.: 2, 3 *ε* N

Then, $2+3 = 5 \epsilon$ N and $2.3 = 6 \epsilon$ N

But the difference of two natural numbers may or may not be a natural numbers. So, a new number i.e. integers are developed.





3.2 Integers

The set of natural numbers together with their negatives including zero are known as the set of integers. 1, 2, 3, 4, are also known as the positive integers and -1, -2, -3, -4, ... the negative integers. The set of integers are denoted by Z or I.

 $\therefore Z = \{ \dots -3, -2, -1, 0, 1, 2, 4, \dots \}$

The sum difference and the product of two integers are again integers. So integers are said to be closed under the operation of addition, subtraction and multiplication.

For e.g.: 2, 3, *ε* Ζ

 $2+3 = 5 \epsilon Z$, $2 \times 3 = 6 \epsilon Z$ and $2 - 3 = -1 \epsilon Z$

But the quotient of two integers may or may not be an integer. So, a new number, i.e. rational numbers are developed.

3.3 Rational numbers

A number in the form of p/q where p and q integers and $q \neq o$ is known as a rational number. The set of rational numbers are denoted by Q.

 $\therefore Q = \{x: x = \frac{p}{q}, p \text{ and } q \text{ are inegers and } q \neq o\}.$

A rational number can also be expressed as a terminating decimal or a repeating decimals. For e.g. :3, -2, $-\frac{3}{2}$, $\frac{1}{3}$, 0.25, 0.66 ... *etc are the* rational numbers.

The sum, difference, product and the quotient of two rational numbers are again rational numbers. So, rational numbers are closed under the operation of addition, subtraction, multiplication and division.But extraction of root of a rational number may not be a rational number. So, again a new number known as an irrational number is developed.

3.4 Representation of a rational number in a real line

The set of rational numbers can be beautifully represented by means of the points on a straight line which is called a real line.



We first see how a number line or a real line can be constructed.

We begin with a straight line. The line is generally taken parallel to the base margin of a copy (i.e. horizontal). We take a fix point 0 say, on it. The direction to the right of 0 is taken to be positive and that to the left is taken to be negative. Points are laid off at equal intervals on either side of 0.We then assign the number 1, 2, 3, ... respectively on the positive side and the numbers -1, -2, -3, ... on the left side of 0.We may further divide and subdivide each segment by introducing more and more points. Such points can be used to represent numbers such as



$$\dots - 3/_1, - 5/_2, - 2/_1, - 3/_2, -1, - 3/_4, - 1/_2, - 1/_4, 0, 1/_4, 1/_2, 3/_4, 1, 3/_2$$

2/1, 5/2, 3/1, ... called rational numbers (i.e. ratio- numbers) or fractions.

3.5 Irrational numbers.

One of the surprising mathematical discoveries was that the system of rational numbers is not adequate to describe all the length that occur in geometry. Let consider the diagonal of square of side 1. What is the length of diagonal?

Then, by Pythagore's Theorem x must satisfy the equation $x^2 = 2$. However there is no rational number that satisfies the equation.

fig (i): Square of unit length having irrational diagonal

 $x^2 = 1^2 + 1^2 = 2$

Theorem 1

There is no rational number x such that $x^2=2$

Proof :-

Suppose that such a rational number x exists. Then we can write $x = \frac{p}{q}$, where $p \in Z$, $q \in N$, where p and q are relatively prime.

The equation $x^2 = 2$ now becomes.

$$p^2/q^2 = 2$$

$$p^2 = 2 q^2$$

Here p is even. So, we can write.

P = 2 r $p^2 = (2 r)^2$

 $p^2 = 4 r^2$

 $2q^2 = 4 r^2$

$$q^2 = 2 r^2$$

 \therefore q is also even

Which contradicts that p and q are relatively prime.

 \therefore No such rational number x exists.

Since we expect equations such as $x^2=2$ to have solutions, we must introduce new numbers that are not rational. We denote the positive solution of this equation, written as $\sqrt{2}$ cannot be rational.





There are many other mathematical quantity which cannot be described exactly by rational numbers.

All these numbers are known as irrational numbers.

3.6 Representation of a irrational number in real line

An irrational number can be represented by a point on the real line. For example, $\sqrt{2}$ is an irrational number. We represent this irrational number in a real line.

To present a point corresponding to $\sqrt{2}$ on a real line, we construct a square OABC of unit length. Join OB. Then,

$$OB = \sqrt{OA^2 + AB^2}$$

$$=\sqrt{1+1}=\sqrt{2}$$

Now, we construct a circle with O as centre and OB as radius cutting the real line at D and E. Then OD = OB = $\sqrt{2}$. Hence D and E represent $\sqrt{2}$ and $\sqrt{2}$ on the real line.



fig(ii): Representation of irrational number in real line

3.7 Real numbers

The rational and irrational numbers together make up the real numbers. The set of real numbers is denoted by R. Each real numbers can be represented as a point on a number line which is also known as the real line.

A diagram showing the family of real number is presented below:





The family members of the real numbers have the following set relation.

 $N \subset Z \subset Q \subset R.$

3.8 Arithmetic in R

We shall need to use arithmetical operations on real numbers, and now we list the properties which these operations satisfy.

| Addi | tion | | Multiplication | |
|------|-------------------------------------|-----|---|---------------|
| A1. | If $a, b \in \mathbf{R}$, then | M1. | If $a, b \in \mathbf{R}$, then | (closure) |
| | $a+b \in \mathbf{R}$ | | $a \times b \in \mathbf{R}$ | |
| A2. | If $a \in \mathbf{R}$ then | M2. | If $a \in \mathbf{R}$, then | (Identity) |
| | a+0 = 0 + a = a | | $a \times 1 = a = 1 \times a$ | |
| A3. | If $a \in \mathbf{R}$, the there | МЗ. | If $a \in \mathbf{R}$, then there | |
| | is a number - $a \in \mathbf{R}$ | | is a number $a^{-1} \in \mathbf{R}$ | (Inverse) |
| | Such that | | such that | |
| | a+(-a) = (-a) + a = 0 | | $a \times (a^{-1}) = (a^{-1}) \times a = 1$ | |
| A4. | If a, b, c, $\in \mathbf{R}$, then | M4. | If $a, b, c, \in \mathbf{R}$, then | (Associative) |
| | (a+b) + c = a + (b+c) | | $(a \times b) \times c = a \times (b \times c)$ | |
| A5. | If $a, b, \in \mathbf{R}$, then | M5. | If $a, b \in \mathbf{R}$ then | (Commutative) |
| | a + b = b + a | | $a \times b = b \times a$ | |

D. If a, b, $c \in \mathbf{R}$, then $a \times (b+c) = a \times b+a \times c$ (Distributive law of multiplication followed by addition).

A set with all these properties is known as field.

3.9 Peano's Axioms

It is at this stage worth meaning that a systematic constructive theory of real numbers can be built on the basis of a set of axioms, known as Peano's Axioms of natural numbers, named after the Italian mathematician Giuseppe Peano (1858-1932). We shall, however, do not go beyond stating the axioms.

Peano's Axioms

- 1) 1 is a natural number.
- 2) If n is a natural number, the successor n' of n is a natural number.
- 3) If two natural numbers have the same successor, the two natural numbers are identical.
- 4) 1 is not successor of any natural number
- 5) If a set contains the natural number 1 and also the successor of every natural number belonging to the set, then every natural belongs to the set.

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In the above axioms, Peano's indefinables are '1' natural number and successor of . As a direct consequence of the above axioms we have the following conclusions:

- a) The set of natural numbers has unending chain of distinct elements.
- b) The elements of the set of natural numbers occupy definite position in the ordered array:
- 1; 2; 3;; n; n+1;; known as the sequence of natural numbers. Here, the number n is called the general term of the sequence.

3.10 Field Axioms

Let R, the set of real numbers together with two binary operations (+) and (.) known as the operations of addition and multiplication, satisfy the following properties of axioms.

Addition Axiom

- 1) Closure property : If $a, b \in \mathbf{R}$ then $a+b \in \mathbf{R}$
- 2) Commutative property; If $a, b \in \mathbf{R}$ then a + b = b + a.
- 3) Associative property If a, b, $c \in \mathbf{R}$, then a+(b+c) = (a+b) + c
- 4) Additive identity For every $a \in \mathbf{R}$, there is a real number 0 such that a + 0 = 0 + a = a
- 5) Additive inverse For every a ∈ **R**, there exists - a ∈ **R** such that a + (-a) = (-a) + a = o Here, -a is known as the additive inverse of a.

Multiplicative Axioms

- 1. Closure property: If $a, b \in \mathbf{R}$ then $a \cdot b \in \mathbf{R}$
- 2. Commutative property; If $a, b \in \mathbf{R}$, then a.b = b.a
- 3. Associative property; If a, b, $c \in \mathbf{R}$, then a (b c) = (a b) c
- 4. Multiplicative Identity;
 For every a ∈ **R**, There exists 1∈ **R** such that 1.a = a. 1 = a
 Here 1 is known as the multiplicative identity.
- 5. Multiplicative inverse : for every $a \in \mathbf{R}$ ($a \neq 0$), there exists $a^{-1} \in \mathbf{R}$ such that $a.a^{-1} = a^{-1}.a = 1$ Here a^{-1} is known as the multiplicative inverse of a.
- 6. Distributive property; For the real number a, b, c the product of a and b + c is same as the products ab and ac





That is, if a, b, $c \in \mathbf{R}$, then a (b+c) = ab+ ac the set \mathbf{R} , together with two binary operations called addition (+) and multiplication (.) and satisfying the above axioms (called field axiom) constitute the field.

3.11 Order Axioms

Besides the field axioms, the real number satisfy the following order axioms also.

A real number a is positive if a>0 and negative if a<0. The product of two positive number is positive. That is if a, $b \in \mathbf{R}$, a>0, b>0 then ab>0.

3.12 The axioms of trichotomy (Trichotomy property)

If a and b be two real numbers then one and only one of the following relations holds.

a < b, a = b, a > b The axiom of transitivity If a, b, c, \in **R**, then a > b, b > c \Rightarrow a > c The axiom of addition Let a, b, c, \in **R** If a > b then a + c > b + c. Also, if a < b then a + c < b + c **The axiom of multiplication** Let a, b, c \in **R** If a > b then ac > bc when c > o If a > b then ac < bc when c < o.

Again if a > b then a/c > b/c when c > o and if a > b then a/c < b/c when c < o.

3.13 Archimedean property

Theorem 2 ; If c > o and if b is any real number, then there exists a natural number n such that nc > b.

Proof :- Let c < o and b be any real number. If possible, suppose the theorem is false. Then $nc \le b$ for each $n \in N$. This shows the set $s = \{ nc: n \in N \}$ is bounded above by b. so, by the completeness axiom of real numbers, so has supremum, say a = supS. Since c > o, ao that a - c < a

Then by the approximation property of supremum, there exists an element n, $c \in S$ for $n \in N$ such that

 $a - c < n, c \le a$ i.e. a - c < n, c





i.e. $a < (n_1 + 1) c$

But $n_{1+1} \in N$ and so $(n_1+1) a \in S$.

This contradicts the assumption that a is the least upper bound for S. Hence, the assumption $nc \le b$ for each $n \in N$ is wrong i.e., there exists some natural number n such that n < b wherever c > o and b is any real number.

This complete the proof.

3.14 Rational density theorem

Theorem 3: If a and b are any natural numbers such that a < b, then there exists a rational number r such that a < r < b.

Proof:- Let a and b be two real numbers such that a < b. Then, clearly c = b - a > o

By, Archimedean property of real numbers, for 1 and c there exists a natural number n such that

n c > l i.e. 1/n < (b - a) (1)

Consider a real number na. Then by the well - ordering property, there exists a natural number n, such that

n- $1 \le na < n$ This give $na < n_1 and n_1 - 1 \le na$ $i.e.a < \frac{n_1}{n} and \frac{n_1}{n} \le \frac{1}{n} + a$ $i.e.a < \frac{n_1}{n} and \frac{n_1}{n} < b - a + a = b$ $i.e.a < \frac{n_1}{n} < b$ Let $r = \frac{n_1}{n}$, as $n_1, n \in N$, clearly r is a rational number. Then,

a< r < b.

3.15 The extended real number system

The extended real number system consists of the real numbers together with two additional symbols, ∞ and - ∞ and satisfying the following properties.

- I. If x is real, then $-\infty < x < \infty$, and $x \pm (+\infty) = \pm \infty$, $x \pm (-\infty) = \pm \infty$, $\frac{x}{+\infty} = \frac{x}{+\infty} = 0$.
- II. If x > 0, then x. $(+\infty) = +\infty$, x. $(-\infty) = -\infty$.





III. If x < 0, then x. $(+\infty)$, x. $(-\infty) = \pm \infty$.

Remember that $\pm \infty$ are not numbers but just symbols. There are unbounded intervals. We have the following notations for unbounded intervals.

| Notation | Set | Graph |
|--------------------|-----------------------------------|---------------|
| (a, ∞) | $\{x: x \ge a\}$ | - |
| [a, ∞) | $\{x: x \ge a\}$ | ••••• |
| $(-\infty, b)$ | ${x : x < b}$ | ← → |
| (-∞, <i>b</i>] | $\{x: x \le b\}$ | ← |
| $(-\infty,\infty)$ | $\{x: -\infty \le x \le \infty\}$ | ←→ |

3.16 Interval

Let a and b be two numbers on the real line. The set of points on the real line between a and b is known as an interval. a and b are known as the end points of the interval. An interval is denoted by I. An interval may or may not include the end points. So, we get four different types of interval.

1. Open- interval;

An interval not containing the end points a and b is known as an open interval It is denoted by (a,b),

Symbolically, $(a,b) = \{x:a \le x \le b\}$

The graph of the above open interval (a, b) is shown below;



2. Closed -interval;

An interval containing both the end points a and b is known as a closed interval. It is denoted by [a, b]

Symbolically, $[a, b] = \{x ; a \le x \le b\}$

The graph of the closed interval [a,b] is shown below.



3. Left open interval;

An interval not containing the end point a and containing the end point b is known as a left open interval. It is denoted by (a, b).

Symbolically, $(a, b) = \{x: a \le x \le b\}$

The graph of the left open interval is shown below;





4. Right -open interval;

An interval containing the end point a and not containing the end point b is known as the right open interval .

It is denoted by [a, b).

Symbolically , [a,b) = {x:a $\leq x < b$ }

The graph of the right open interval [a, b) is shown below.



fig (vii) : Right - open interval

3.17 Absolute value

Let x denote any real number. The absolute value (or modulus or numerical value) of x, written as |x|, is a non-negative real number defined by

$$|x| = \begin{cases} x & if \quad x \ge o \\ -x & if \quad x < o \end{cases}$$

Clearly, $|x| \ge o$. Geometrically speaking, the absolute value of x is the distance of the point x on the real line from the origin. i.e., the point O. Moreover the distance between any two points a and b on the real line is

|a-b| = |b-a|.

Examples:

 $|-3| = -(-3) = 3, |3| = 3, |0| = 0, |\pi| = \pi$

Some simple properties of absolute values are discussed below;

1. Let x by any real number. Then

```
(i) |x| \ge 0
(ii) |x| \ge x and |x| \ge -x
(iii) - |x| \le x \le |x|
```

Proofs

```
Let x \epsilon R
```

```
(i) If x = 0, then |x| = 0
If x > 0, |x| = x > 0
```

```
If x < 0, |x| = -x > 0
```

```
\therefore for all \ x \in R, |x| \ge 0
```

(ii) If $x \ge 0$, then $x \ge -x$ and $|x| = x \therefore |x| \ge -x$ Again if $x \le 0$, then $-x \ge x$ but |x| = -x





 $\therefore |x| \ge x$

(iii) $|x| \ge x = x \le |x|$

again, $|x| \ge -x = x \ge -|x|$

Combining the two results

 $-\left|x\right|\leq x\leq\left[x\right]$

- 2. For any two real numbers x and y.
 - a) $|x + y| \le |x| + |y|$ (Triangle Inequality)

b)
$$|x - y| \ge |x| - |y|$$

Proofs

a)
$$|x + y| \le |x| + |y|$$
 (Triangle Inequality)
 $|x + y|^2 = (x + y)^2$
 $= x^2 + 2xy + y^2$
 $= |x|^2 + 2xy + |x|^2$
 $\le |x|^2 + 2|x||y| + |y|^2$
 $(\therefore |x| \ge x \text{ and } |x| \ge x \text{ and } |x| \ge y$
 $= (|x| + |y|)^2$
 $\therefore |x + y| \le |x| + |y|$
b) Let $x = z$. Then $x = y = y = z$ and

b) Let x-y = z. Then, x= y+z and

$$|x| = |x + y| \le |y| + |z| = |y| + |x - y|$$

Hence, by transposition,

We get,

 $|x - y| \ge |x| - |y|$

3. For any two real numbers x and y

a)
$$|xy| = |x||y|,$$

b) $|x/y| = \frac{|x|}{|y|}, y \neq 0$

Proofs:-

a) for x, y
$$\in$$
 R
 $|xy|^2 = (xy)^2 = x^2y^2$
 $= |x|^2|y|^2$
 $\therefore |xy| = |x||y|$

b) for x, y $\epsilon l R (y \neq 0)$ $|x/y|^2 = (x/y)^2$



$$= \frac{x^2}{y^2}$$
$$= \frac{|x|^2}{|y|^2}$$
$$\therefore x/y = \frac{|x|}{|y|}$$

4. If $x \in \mathbf{R}$ and a be any positive real number then |x| < a > -a < x < a and conversely.

proof:

```
For all x \in \mathbf{R}, |x| \ge x
      Given, |x| < a
      \therefore x \leq |x| < a
      => x < a
                                          (i)
Again for all x \in lR, |x| \ge -x
      Given |x| < a
      \therefore -x \le |x| < a
      = -x < a
      = x > -a
                                           (ii)
Combining (i) and (ii)
      -a < x < a
      Conversely
      i.e. If - a < x < a, then |x| < a
      firstly, x < a
      If x \ge 0, then |x| = x
      |x| = x < a
                                           (i)
Again, -a < x
      = x > -a
      = -x < a
But for x < 0, |x| = -x
      \therefore |x| = -x < a
                                          (ii)
For all x \in lr, (from (i) and (ii)
      |x| < a Note: for x \in \mathbf{R}, a > o
      |x| \le a = -a \le x \le a
      and conversely
```

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3.18 Complex numbers

Suppose that we extend the set of real numbers by introducing a new number denoted by i, which is defined to have the property that $i^2 = -1$. Suppose, further that i combines with itself, and with real numbers, according to the usual flues of arithmetic. Such sums are known as complex numbers. In particular assume that we can multiply i by any real number to obtain the product ib and then we can add on any real number a to obtain the sum a+ ib. Such sums are known as complex numbers.

Two complex numbers are equal when their real part and their imaginary parts are equal.

For example, if z=2-3i, then Rez = 2 and Imz=-3.

<u>Remarks</u>

- 1) Any given real number x can be written in the form x + i0, and any complex number of the form x + i0 is usually written simply as x. In this sense, R is a subset of c. The zero complex number 0+i0 is written as o.
- 2) We usually write a general complex number as x+iy, and a particular complex number as, for example, 2-3i rather than 2+(-3i).
- 3) Note that Re z and Im z are both real numbers.
- A complex number of the form 0 + ly (where y≠0) i sometimes called an imaginary number.
 If we assume that the usual rules of arithmetic apply, then we can solve quadratic equations using the quadratic formula and the fact that √-1 = i

3.19 Polynomial equation

A polynomial equation in x of degree n is an equation of the form p(x)=0, where p(x) is a polynomial of degree n.

Polynomial equations (and polynomial) of degrees 1, 2 and 3 are called linear, quadratic and cubic respectively.

Recall that the formula for the solutions of the quadratic equation

$$ax^{2} + bx + c = 0 \text{ is}$$
$$x = \frac{-b \pm \sqrt{b^{2} - 4ac}}{2a}$$

This equation is known as the quadratic formula.

3.20 Nature of the roots of Quadratic equation

Let two roots of the quadratic equation

 $ax^2 + bx + c = 0 \quad (a \neq o)$

be denoted by \propto and β and so that

$$\alpha = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$



and $\beta = \frac{-b - \sqrt{b^2 - 4ac}}{2a}$

- i. If $b^2-4ac > o$, then the roots are real and unequal
- ii. If b²-4ac=0, then the roots are real and equal, each being $\frac{-b}{2a}$
- iii. If $b^2-4ac > 0$, then the roots are imaginary and unequal.

3.21 The complex plane

Just as there is a one-one correspondence between the real numbers and the point on the real line, so there is a one-one correspondence between the planes. This correspondence is given by

 $f: \boldsymbol{C} = \boldsymbol{R}^2$

x + iy = (x, y)

If we can represent points in the plane by complex numbers and conversely, we can represent complex numbers by points in the plane, we refer to the plane, we refer to the plane as the complex plane, and we often refer to the complex numbers as points in the complex plane. A diagram showing complex numbers represented as points in the plane in this way it sometimes called an Argand diagram.

The French mathematician Jeah-Robert argand's publication of the idea in 1806 was first to be generally recognized.



Real numbers are represented in complex plane by points on the x-axis, the axis is called real axis. Similarly, numbers of the form iy are represented by points on the y-axis, this axis is called imaginary axis.

3.22 Complex conjugate

Many manipulations involving complex numbers, such as division, can be simplified by using the idea of a complex conjugate, which we now introduce.

The complex conjugate \overline{z} of the complex number z = x + iy is the complex number x-iy



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For example, if z = 1-2i, then $\bar{z} = 1 + 2i$. In geometric terms, \bar{z} is the image of z under reflection in the real axis.

3.23 Properties of complex conjugate

Let z_1 , z_2 and z be any complex numbers.

Then;

i)
$$\overline{z_1 + z_2} = \overline{z_1} + \overline{z_2}$$

ii) $\overline{z_1 \overline{z_2}} = \overline{z_1} \times \overline{z_2}$
iii) $\overline{z_1 \overline{z_2}} = \overline{z_1} \times \overline{z_2}$
iii) $z + \overline{z} = 2 \operatorname{Rez}$
iv) $z - \overline{z} = 2i \operatorname{Imz}$
Property (i) $\overline{z_1 + z_2} = \overline{z_1} + \overline{z_2}$
Proof:-
let $z_1 = x_1 + iy$, and $z_2 = x_2 + iy_2$. Then $\overline{z_1}$
 $= x - iy$, and $\overline{z_2} = x_2 - iy_2$
 $\overline{z_1 + z_2} = \overline{(x + iy_2) + (x_2 + iy_2)}$
 $= \overline{(x_1 + x_2) + (y_1 + y_2)}i$
 $= (x_1 + x_2) - (y_1 + y_2)i$
 $= (x_1 + y_1i) - (x_2 + y_2i)$
 $= \overline{z_1} + \overline{z_2}$ proved
Property (ii)
 $\overline{z_1 \overline{z_2}} = \overline{z_1} \times \overline{z_2}$

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Proof:-

 $\overline{z_{1}z_{2}} = \overline{(x_{1} + y_{1}i)(x_{2} + y_{2}i)}$ $= \overline{(x_{1}x_{2} + x_{1}y_{2}i + x_{1}y_{1}i - y_{1}y_{2})}$ $= \overline{(x_{1}x_{2} - y_{1}y_{2}) + (x_{1}y_{2} + x_{2}y_{1})i}$ $= (x_{1}x_{2} - y_{1}y_{2}) - (x_{1}y_{2} + x_{2}y_{1})i$ $= (x_{1} - y_{1}i) - (x_{2} + y_{2}i)$ $= \overline{z_{1}} \times \overline{z_{2}} \text{ proved}$ Property (iii) $z + \overline{z} = 2 \text{ Rez}$ Proof: $z + \overline{z} = (x + iy) + (x - iy)$ = 2x = 2 RezProperty (iv) $z - \overline{z} = 2 \text{ I mz}$ Proof: $z - \overline{z} = (x + iy) - (x_{-}iy)$ = 2 iy = 2 Imz.

3.24 Modulus of a complex number

As we know, $|\mathbf{x}|$ is the distance from the point x on the real line to the origin. We extend the definition to complex numbers as follows. The modulus $|\mathbf{z}|$ of a complex number z is the distance from the point z in the complex plane to the origin. Thus the modulus of the complex number z = X + iy is $|\mathbf{z}| = \sqrt{x^2 + y^2}$

$$|\mathbf{z}| = \sqrt{x^2 + y^2} \qquad \mathbf{z} = \mathbf{x} + \mathbf{i}\mathbf{y}$$



fig(x) : Modulus of complex number in complex plane





For example, if z = 3-4 i, then

$$|\mathbf{z}| = \sqrt{3^2 + (-4)^2} = \sqrt{25} = 5.$$

3.25 Distance formula

The distance between the points z_1 and z_2 in the complex plane is $|z_1 - z_2|$.

This is obtained by applying Pythagoras theorem to the triangle in the diagram below.



3.26 Conjugate modulus properties

i)
$$|\bar{z}| = |z|$$
 for all $z \in C$
ii) $Z\bar{z} = |z|^2$ for all $Z \in C$
Property (i): $|\bar{z}| = |z|$
proof let $Z = X + iy$ then $\bar{z} = x - iy$
 $|\bar{z}| = \sqrt{x^1 + (-y)^2}$
 $= \sqrt{x^2 + y^2}$
 $= |z|$
Property (iii) $:z\bar{z} = |z|^2$
 $z\bar{z} = (x + iy)(x - iy)$
 $= x^2 - 1^2y^2$
 $= x^2 - (1)y^2$
 $= x^2 + y^2$
 $= (\sqrt{x^2 + y^2})^2$
 $= |z|^2$



3.27 Division of complex numbers

The second of the conjugate- modulus properties enables us to find reciprocals of complex numbers and to divide one complex number by another. As for the real numbers, we cannot find a reciprocal of zero, nor divide any complex number by zero.

3.28 Arithmetic properties of complex numbers

The set of complex numbers **C**, satisfies all the properties previously given for arithmetic in R. We state these properties here.

Arithmetic in C

| Addition | | Mult | Multiplication | | |
|----------|--|------|---|-----------------|--|
| A1. | If $z_1, z_2 \in C$ then | M1. | If $z_{1,}z_{2} \in C$ then | (closure) | |
| | $z_1+z_2 \in C$ | | $z_1 \times z_2 \in \mathbb{C}$ | | |
| A2. | If $z \in C$ then | M2. | If $z \in C$ then | (Identity) | |
| | z + 0 = 0 + z = z | | $z \times 1 = 1 \times z = z$ | | |
| A3. | If $z \in C$, then there | M3. | If $z \in \mathbb{C} - \{0\}$, then there | (Inverse) | |
| | is a number $-z \in C$ | | is a number $z^{-1} \in C$ such | | |
| | such that | | that | | |
| | z+(-z) = (-z) + z = 0 | | $z \times z^1 = z^1 \times z = 1$ | | |
| A4. | If $z_1, z_2, z_3 \in C$, then | M4. | If $z_{1,}z_{2,}z_{3} \in \mathbf{C}$, then | (Associatively) | |
| | $(z_1+z_2)+z_3=z_1+(z_2+z_3)$ | | $(z_1 \times z_2) \times z_3 = z_1 \times (z_2 \times z_3)$ | | |
| A5. | If $z_{1,}z_{2} \in C$ then | M5. | If $z_1, z_2 \in C$ then | (Commutative) | |
| | $z_1 + z_2 = z_2 + z_1$ | | $z_1 \times z_2 = z_2 \times z_1$ | | |
| D. | If $z_1, z_2, z_3 \in C$ then | | | (Distributive) | |
| | $z_1 \times (z_2 + z_3) = z_1 \times z_2 + z_1 \times z_3$ | | | | |

In particular, 0 = 0 + 0i plays the same role in **C** as the real number o does in R, and 1 = 1 + 0i plays the same role as 1. These numbers are called identities for addition and multiplication respectively.

We also have that the additive inverse (or negative) of z = x + i y is -z = -x - yi, and the multiplication inverse (or reciprocal) of z = x + yi is

$$\frac{\bar{z}}{|z|^2} = \frac{x - iy}{x^2 + y^2}$$

This is one important difference between the set of real numbers and the set of complex numbers, however, namely that, unlike the real numbers, the complex numbers, the complex numbers are not ordered.

For any two real number a and b, exactly one of the three properties a<b, a=b or a>b is true. But this is not the case for the complex numbers; we cannot say. For example, that

1+2i>-1+3i or 1+2i = -1+ 3i or 1+ 2i < -1+3i

3.29 Polar form

We have seen that the complex number x + iy corresponds to the point (x,y) in the complex plane. This correspondence enables us to give an alternative description of complex numbers, using socalled polar form. This form is particularly useful when we discuss properties related to multiplication and division of complex numbers.



fig(xii) : Representation of complex number in polar form

Polar form is obtained by noting that the point in the complex plane associated with the non-zero complex number z = x+iy is uniquely determined by the modulus; $r = |z| = \sqrt{x^2 + y^2}$, together with the angle θ (measured in an anticlockwise direction in radian) between the positive direction in radians) between the positive direction of the x-axis and the line from the origin to the point, as shown in the graph above. We have.

 $x = r\cos\theta$ and $y = r\sin\theta$

So, the complex number z can be expressed as

$$z = r(\cos \theta + i \sin \theta)$$

: A non-zero complex number z = iy is in polar form if it is expressed as $r(\cos \theta + i\sin \theta)$ where r = |z| and θ is any angle between the positive direction of the x- axis and the line joining z to the origin.

3.30 Modular Arithmetic

Division:

In this section instead of enlarging the number system R, we do arithmetic with finite set of integers, namely the possible remainders when we divide by particular integers.

If we divide one positive integer by another we obtain a quotient and a remainder. For example, 29 divided by 4 gives quotient 7 and remainder 1 because $29 = 7 \times 4+1$. If we divide any positive integer by 4, the remainder will be one of the numbers 0, 1, 2, 3.

This idea can be extended to the division of a negative by a positive integer. For example, -19 divided by 4 gives quotient -5 and remainder 1 because $-19 = (-5) \times 4+1$. If we divide any negative integer by 4, the remainder is again one of the number 0, 1, 2, 3.

Let a and n be integers, with n>o. Then there are unique integers q and r such that

a = qn + r with $o \le r \le n$.





3.31 Congruence

Let n be a positive integer. Two integers a and b are congruent modulo n if a-b is multiple of n; that if a and b have the same remainder on division by n.

In symbols we write

 $a \equiv b \pmod{b}$

(we say 'a' is congruent to b modulo 'n')

Such a statement is called a congruence and n is called the modulus of the congruence.

3.32 Properties of congruence

Let n and k be positive integers, and Let a, b, c, d be integers. Then

```
i.
         a \equiv a \pmod{n}
  ii.
         If a \equiv b \pmod{b}, then b \equiv a \pmod{b}
 iii.
         If a \equiv b \pmod{and b} \equiv c \pmod{a}, then a \equiv c \pmod{a}
         If a \equiv b \pmod{a} and c \equiv d \pmod{b}, then a+c \equiv b+d \pmod{b}
 iv.
         If a \equiv b \pmod{and c} \equiv d \pmod{b}, then ac \equiv bd \pmod{b}
  v.
         If a \equiv b \pmod{k}, then a^k \equiv b^k \pmod{k}
 vi.
Property (i) a \equiv a \pmod{n}
Proof : a - a = 0 = 0 \times n, so, a \equiv a \pmod{proved}
Property (ii) a \equiv b \pmod{}, then b \equiv a \pmod{}
Proof: suppose that, a \equiv b \pmod{}. Then a - b = kn for some integer k.
Hence b-a = (-k)n so b \equiv a \pmod{proved}
Property (iii) a \equiv b \pmod{a} and b \equiv c \pmod{b}, then a \equiv c \pmod{c};
Proof :. Suppose that a \equiv b \pmod{a} and b \equiv c \pmod{b}. Then a-b = kn and b-c = ln for some integers k
and l. hence
a - c = a - b + b - c = kn + ln = (k + l)n
So, a \equiv c \pmod{n}
Property (iv) : If a \equiv b \pmod{a} and c \equiv d \pmod{b}, then a+c \equiv b+d \pmod{b}
Proof : If a \equiv b \pmod{and c} \equiv d \pmod{a}.
Then
a - b = kn and c - d = ln for some integers k and l. Hence a = b + kn and c = d + ln.
So, a + c = b + kn + d + ln = b + d + (k + 1) n.
Hence (a + c) - (b + d) = (k + l) n, so a + c \equiv b+d \pmod{n}.
Property (v) : If a \equiv b \pmod{a} and c \equiv d \pmod{b}, then ac \equiv bd \pmod{b}
Proof If a \equiv b \pmod{and c} \equiv d \pmod{and}.
Then,
a-b \equiv kn and c - d \equiv ln
a = b + kn and c = d + ln
Now ac = bd + bln + kdn + kln^2
ac-bd = (bl + kd + kln) n
ac \equiv bd (modn).
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4. Application,

4.1 Application

The application of number system are

- 1) Represent a useful set of numbers (e.g. all integers or rational numbers)
- 2) Give every number represented a unique representation (or at least a standard representation)
- 3) Reflect the algebraic and arithmetic structure of the numbers.
- 4) To find speed in general, a numerical value obtained by measuring distance and time.
- 5) Weather, air temperature, wind speed and direction nature.
- 6) Airplane flight deck instruments, altitude, speed.
- 7) Car driving, instruments, dashboard, fuel amount, speed, engine temperature.
- 8) Show the graph of stock prices.

4.2 Examples:

1) Show that there is no rational number x such that $x^3 = 2$.

Proof:

Suppose that there exists a rational umber x such that $x^3 = 2$. We can write x = p/q where p and q are positive integers whose greatest common factor is 1.

Then the equation

 $x^3 = 2$ becomes

 $p^3 = 2q^3$

Here p is even

Let p = 2r then equation becomes

 $(2r)^3 = 2q^3$

So we have

 $q^3 = 4r^3$

Hence, q is also even, so 2 is a common factor of p and q. This contradiction shows that such a number x cannot exist.

2) Solve the following quadratic equations, stating how many solutions each equations has in R.

a)
$$x^2 - 7x + 12 = 0$$

b)
$$x^2 + 6x + 9 = 0$$

a)

 $sol^n: x^2 - 7x + 12 = 0$

Using quadratic formula

$$x = \frac{7 \pm \sqrt{49 - 48}}{2} = \frac{7 \pm \sqrt{1}}{2}$$

$$=\frac{7\pm1}{2}=\frac{6}{2}$$
 or $\frac{8}{2}$
x = 3.4

This equation has two solution in R.

b)

solⁿ: $x^2 + 6x + 9 = 0$

Using quadratic formula

$$\mathbf{x} = \frac{6 \pm \sqrt{36 - 36}}{2} = \frac{6 \pm \sqrt{0}}{2} = \frac{-6}{2} = -3.$$

This equation has one solution in R.

3) Represent the following in set and in real line

- a. [-6, 2]
- b. $(-\infty, 3]$
- c. $(-2, \infty)$
- d. (-3, 3)

a) solⁿ: Set representation for interval [-6, 2] [-6, 2] = { $x:-6 \le x \le 2$ } $-6 \le x \le 2$



fig(xiii) : Representation of [-6,2] in real line

So on....

4) Solve the following equations.

a) $z^2 - 2z + 5 = 0$

Solⁿ: We often consider complex variables by z.

for the above equation, the quadratic formula gives

$$z = \frac{2 \pm \sqrt{-16}}{2}$$
$$= \frac{2 \pm \sqrt{-16} \sqrt{1}}{2}$$
$$= \frac{2 \pm 4i}{2}$$
$$= 1 \pm 2i$$

We can check these two complex numbers satisfy the equation we were trying to solve. We use the usual rules of arithmetic and substitute -1 for i^2 wherever it appears.

For example, if z = 1 + 2i, then

$$z^{2}-2z+5 = (1+2i)^{2}-2(1+2i)+5$$
$$= 1+4i+4i^{2}-2-4i+5$$

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= 1 + 4 i - 4 - 2 - 4 i + 5= 0 Now for z = 1 - 2i z²-2z+5 = (1 - 2i)²-2(1 - 2i) + 5 = 1 - 4i + 4i²-2 + 4i + 5 = 1 - 4i - 4 - 2 + 4i + 5 = 0 b) z⁴-16 = 0 Solⁿ (z²)²- (4)² = 0 or (z²-4) (z²+4) = 0 Hence z = 2 or z = -2 or z = 2i or z = -2i

5) For each of the following pairs Z_1 , Z_2 of complex numbers, draw a diagram showing Z_1 and Z_2 in the complex plane, and evaluate $|Z_1 - Z_2|$.



Now,

 $|z| + |w| \ge |z + w|$ will be true

If
$$\sqrt{a^2 + b^2} + \sqrt{c^2 + d^2} \ge \sqrt{(a + c)^2 + (b + d)^2}$$

i.e. $a^{2+}b^2 + c^2 + d^{2+}2\sqrt{(a^2 + b^2)(c^2 + d^2)} \ge (a + c)^2 + (b + d)^2$
i.e. $\sqrt{(a^2 + b^2)(c^2 + d^2)} \ge ac + bd$
i.e. $(a^2 + b^2)(c^2 + d^2) \ge a^2c^2 + b^2d^2 + 2abcd$
i.e. $a^2d^2 + b^2c^2 \ge 2abcd$
i.e. $a^2d^2 + b^2c^2 - 2abcd \ge 0$
i.e. $(ad - bc)^2 \ge 0$

Which is true for all real numbers a, b, c, d.

Hence,

 $|z| + |w| \ge |z + w|$

7) <u>De Moivre's Theorem</u> :-

If n is any positive integer, then prove that,

 $[r(\cos\theta + i\sin\theta)]^n = r^n(\cos\theta + i\sin\theta).$

Proof:

 $[r(\cos\theta + i\sin\theta)] = r(\cos\theta + i\sin\theta).$

Obviously, when n=1,

For n = 2, We have $[r(\cos\theta + i\sin\theta)]^2$ $= r^2(\cos^2\theta + 2i\cos\theta\sin\theta + i^2\sin^2\theta)$ $= r^2(\cos^2\theta - \sin^2\theta + i2\sin\theta\cos\theta)$ $= r^2(\cos2\theta + i\sin2\theta)$

Thus the theorem is true for n = 1 and n = 2. We prove the theorem by induction.

Let us assume that the theorem is true for some positive integer K.

By assumption,

 $[r(\cos\theta + i\sin\theta)]^{K} = r^{K}(\cosk\theta + i\sink\theta).$

Multiplying both sides by $r(\cos\theta + i\sin\theta)$,

We get,

 $[r(\cos \theta + i \sin \theta)]^{K+1}$ = $r^{K+1}(\cos k \theta + i \sin k \theta)(\cos \theta + i \sin \theta)$ = $r^{K+1}[\cos(k\theta + \theta) + i \sin k(k\theta + \theta)]$ = $r^{K+1}[\cos(k+1)\theta + i \sin k(k+1)\theta].$

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Which shows that the theorem is true for n = K+1 when ever it is true for n = K.

But we know that it is true for n = 1 and n = 2. When it is true for n = 2, the above proof shows that it is true for n = 3. Continuing this way, we come to the conclusion that the theorem is true for every position integer n; This completes the proof.

5. Conclusion:-

After studying and preparing this report we could be able to explain the meaning of number system, their arithmetical properties, some axioms, we could also explain terms modulus, inequality, solve linear, quadratic, polynomial equations.

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SECTION - B SOCIAL SCIENCE





Relationship between Rewards Satisfaction and Work Performance in Finance Companies



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1. Abstract :-

This study aimed to examine relationship between pay level and work performance, to examine relationship between benefits and work performance, to examine relationship between raise satisfaction and work performance and to examine relationship between salary administrative and work performance. Out of 200 employees, only 175 respondents from four finance companies were provided their responses. It was found that work performance existing among the respondents. Significant values for each element in independent variable which the item of reward such as pay level, benefit, raise and structure. Finding of this study would provide manager to understanding about the relationship between reward items such as; pay level, benefit, raise and structure with the work performance.

Keywords

Rewards satisfactions, work performance, pay level, benefit.

Introduction

It is common that performance of the employees will directly affect the performance of the organizations. In essence, if the performance of a majority of the employees is low, this would inevitably lead to low organizational performance, and vice versa (Mokhtar, 2011). However, from the perspective of the employees, work performance is also important to them because there is a constant need among them to upgrade their standard of living or more specifically increase their income. As human, improving the quality of life is a must for most people, and therefore they will actively seek employment at organizations that provides higher salary, incentives and benefits, or in other words organizational rewards. This situation poses complication to the top managers and also the working environment because rewards are like a two-edge sword. Although reward generally has a good impact on the individual performance (Billikop, 2006), it also is known to negatively affect performance (Amiable, 1982). In short, though rewards are important for employee work performance (Mokhtar, 2011).

In order to exhibit high performance, the employees must like the rewards that they receive from the organization. They must be satisfied with the rewards (Stredwick, 2000). Although studies on reward satisfaction are many (Ducharme, Singh, & Podolsky, 2005; Vest, Scott, & Markham, 1994; Wu & Wang, 2008), most of them are outdated and may not be relevant in today's context. Furthermore, these studies did not exactly study the impact of different types of organizational rewards on individual work performance. For example the study by Vest, Scott, and Markham (1994) looked into the relationship between self-rated performance and pay satisfaction, and the study by Wu and Wang (2008) investigated the relationship between pay fairness and employees' pay satisfaction. Work





performance to the significant of reward satisfaction, especially to the organization and employees perceive, their experience are differential satisfaction with the dimension of pay level, benefit, and raise and structure (Heneman III & Schwab, 1985). Therefore, it is high time a study to be conducted to examine the impact of various organizational rewards on individual work performance. The key terminologies used in this study are shown in the following table.

| Key Terminology | Definition | Author(s) | |
|--------------------|--|--------------------|--|
| Organizational | How employee feels from what they had received | Heneman and | |
| reward | from organization | Schwab (1985) | |
| Pay level | Pay level satisfaction refers to individual's | Heneman and Schwab | |
| | satisfaction towards his/her current direct (wage or | (1985) | |
| | salary) compensation. | | |
| Benefits | Benefits satisfaction refers to satisfaction towards | Heneman and | |
| Satisfaction | indirect pay in the form of payment for time not | Schwab (1985) | |
| | worked, insurance, pension, income maintenance | | |
| | and miscellaneous services. | | |
| Raise | Raise Raise satisfaction refers to individual's changes in | | |
| satisfaction | pay level. | Schwab (1985) | |
| Salary | Heneman and | | |
| administration | Schwab (1985) | | |
| Work | Williams and | | |
| performance | Anderson (1991) | | |
| | him/her at a certain position. | | |

Table 1: List of Key Terminologies0

Research Framework

The research framework which introduced by Ballentine and Scarpello (2009) is given as below:



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In this study, work performance is the dependent variable. Pay level, benefits satisfaction are include training, health and employee right, raise satisfaction and salary structure or administration are taken as independent variables. Based on this framework, the major hypotheses of the study are as follows.

- H1: There is a positive and significant relationship between pay level and work performance
- H2: There is a positive and significant relationship between benefit and work performance
- H3: There is a positive and significant relationship between raise satisfaction and work performance
- H4: There is a positive and significant relationship between salary structure and work performance

Methodology

This is a descriptive research study that aims to explain the relationship between reward satisfaction and work performance. This study more or less followed the methodology used by Mokhtar (2011). Out of 200 questionnaires distributed, only 175 respondents (employees) from four finance companies were given responses. Measurement scale for section are based on a Likert Scale of 1 to 5, (where 1=strongly dissatisfied, 2=dissatisfied, 3=nor dissatisfied, 4=satisfied and 5= strongly satisfied. For the measurement of satisfaction, 1= strongly disagree, 2= disagree, 3= not sure, 4= agree and 5= strongly agree). The questionnaire used in this study was developing partly based on the works of Heneman III and Schwab (1985), and William and Anderson (1991).

Results and Discussions

This section presents and empirical results of this study. The results are illustrated in the following table.

| Variables | Mean | SD | WP |
|---|------|------|------|
| Pay level satisfaction | 3.15 | 0.79 | 0.21 |
| Benefits satisfaction | 3.43 | 0.82 | 0.43 |
| Raise satisfaction | 3.35 | 0.86 | 0.22 |
| Salary administration satisfaction | 3.48 | 0.89 | 0.17 |
| Work Performance | 3.63 | 0.61 | 1 |
| Significant at * $p < 0.05$, ** $p < 0.01$ (2-talied). | • | • | • |

| Table 2: | Descriptive | Analysis | and | Correlations |
|----------|-------------|----------|-----|--------------|
|----------|-------------|----------|-----|--------------|

The results show that for the 4 dimension of reward satisfaction to work performance, the highly correlation to the pay level (r=0.21, p>0.01), for the benefit satisfaction and work performance are also high correlated (r=0.43, p>0.01), for the raise is also had highly correlated with (r=0.22, p>0.01), and for the salary administration are also had a highly correlated with (r=0.17, p>0.01). However, they are not significantly correlated. Thus, it can conclude there are not significant to the work performance, which the pay level had contributed to the higher degree of the relationship. In this study, it was hypothesized that all the elements were to have a positive and significant relationship. However, based on the findings all the hypotheses are rejected.





Conclusions

This study shows that there is no significant relationship between pay levels satisfaction and work performance. This means that regardless whether employees are satisfied or not satisfied with their current pay level, it does not affect the level of their work performance. The findings of this study is in contrast to the study by Till and Karren (2011) who found that pay levels and the reward are related each other. Nonetheless, according to Williams, McDaniel, and Nguyen (2006), pay satisfaction is probably a function of the discrepancy of perceived pay level and the amount that the employee believes their pay should be. Hence, one possible explanation for the insignificant relationship between pay level satisfaction and work performance is that on average the level of satisfaction is not that high, and this is evident when looking at the mean pay level satisfaction. This study also shows that there is no significant relationship between benefits satisfaction and work performance. Although previous literatures did not indicate the relationship between benefits satisfaction and work performance, some studies have shown positive association between satisfaction with benefits and job satisfaction (Berger, 1984; Gresham, 2006; Lust, 1986). In general, job satisfaction is highly correlated to work performance, more specifically organizational citizenship behaviors (Faizuniah & Salniza, 2008; Yoon & Suh, 2003). Nonetheless the findings by a research by Khulida Kirana, Faizuniah, Johanim, Mohd Faizal and Zulkiflee (2008), showed that only certain elements of employee benefits have any form of effect on job satisfaction, mainly medical, housing and paid-leave. Since, this study does not focus on any specific element of employee benefits; it is difficult to determine why benefits satisfaction has no significant relationship with work performance.

Based on the finding of the study there is no significant relationship between raise satisfaction and work performance. This is an area that has not been extensively explored by researchers. The finding of this study indicates that whether the employees are satisfied or not does not have any effect on their performance. Although, previous studies does not look specifically into the relationship between these two variables, pay raise satisfaction has been shown to relate to favorable employee behavior, for example, it was found to negatively related to turnover (Tekleab, Bartol & Liu, 2005). Based on the study there is no significant relationship between salary administration and work performance. Finally, employees' satisfaction towards the four types of organizational rewards, mainly pay level, benefits, raise and salary administration do not have any significant relationship with employees' work performance. This means that regardless of their level of satisfactions on these organizational rewards, it has no effect on their work performance.

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Status of Labour Migrants and their Families in Far-Western Nepal



1₩c

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Abstract

Migration is the process of human life. In earlier, people were migrated for getting food and shelter as their conveniences. Migration in far western region shows the typical situation where people migrate to Terai region as permanent migrants and go to India for searching the jobs (foreign employment) as seasonal migrants. Some people (resourceful) migrate towards Gulf Countries, Malaysia and other third countries but having low status many people choose India as their destination. There is unemployment and less opportunity in rural areas which is the major push factor for migration. Hundreds of far western people having weak and poor family backgrounds move to India for their survival and searching job opportunities. There is not the exact data for the migrant workers in India. The mail objective of this study was to identify the socio-economic status of labour migrants and their families in far-western region. Research was carried out in some wards of Shikhar municipality of Doti district and 2 municipalities in Kanchanpur (Punurbas and Mahakali). All together 300 HHs were carries out as a sample size. Questionnaires were filled up by the support of enumerators and researcher himself visited to each location for testing and verification of the collected data. Field observation as well as depth interview was carried out at household level. It was found that about 70 % households represented as migrant workers in India. The reason of feeling harassment is due to illiteracy and poor skill on works. As a result, they could not achieve the expected job opportunities except labour work (physical work). They could not earn much and perhaps leave their destination without any information. Furthermore, migrant workers having innocent nature and lack of knowledge about the rules and regulation in the cities, it causes them to be imprisoned in false cases.

KEY WORDS: Migration, Labour Migrants, Origin, Destination, Foreign Employment

Mr. Bhatt has a decade long experiences on the social works/NGO field as well as the field of journalism.

Introduction

Poverty is the main cause of migration of local people towards India. Many of the people are migrated for searching the opportunities and the number is being increased day to day. Most of them looks satisfied with their job though their livelihood status is not still improved as their expectation. Due to lack of opportunities in origin, they are compelled to work in destination. The general objective of the research is to identify the current situation/position of the migrant workers and their families and concerning issues.

Generally migration is known as the movement of people from their place of usual residence to somewhere else. In the early ages of human beings, people used to live temporarily in one place but slowly development of agriculture system people started living permanently. In this

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age of globalization, the migration is taking place broadly. People have different purposes of migration. Most of the people migrate for the purpose of earning money and study abroad. Millions of migrant workers are there in the world from which some developed countries are taking advantages unlimitedly but some countries like Nepal are getting trouble. Disappearance of skilled manpower has affected the poor nations very badly.

Since, migration is a complex phenomenon, it is difficult to classify exactly. It can be classified according to motive, distance and duration. Janawali, 2004 addressed about the voluntary migration which can be classified into two major types

- Internal and
- External

Both of them are temporary and permanent. Temporary migration is further divided into three types.

- Seasonal
- Periodical and
- Daily

This study was basically focused on seasonal labor migration in which people go to outside the village in order to send back remittance to their families. In the case of temporary migration people leave the residence for certain period of time. Such mobility is defined as circular or seasonal migration which can be internal and external.

Although migration is a phenomena that has taken place since the history of mankind, its theoretical interpretation is found in the 'laws of migration' first defined by **Ravenstein (1885)**. His conclusion was based on geographical prospects like reasons, distance, migrant characteristics and gender with migration. Furthermore, Ravenstien showed the step on migration, i.e rural-town-city-metropolitan city. He further explains:

- Migrants are mainly over short distance; those going longer distance go for industry and commerce.
- Most migration is from agricultural/ rural to industrial/urban areas.
- Large town grows more by migration then by natural increases.
- Migration increases along with the development of industry, commerce and transport.
- Each migration stream produces a counterstream.
- Female are more migratory than males, at least over shorter distances, males are a majority in international migration.
- Major causes of migration are economic.
- Most migration proceeds step by step.

Migration has a long history in Nepal in the past; Nepal had been a country of destination of immigrants from both north and south. International labor migration began especially since the First World War in Nepal around 200 years ago. People of Nepal have been migrating since the treaty of Sugauli (1816) at the first quarter of the 19th century. Nepalese migrants were also forced for recruitment to the British army in colonial India and abroad (K.C. et. al. 1995).

(Khadka, 1979) provides a micro level study of Balyalpata in Achham on emigration. The study broadly defining migration includes push factors as non-availability of land and work in the village, lack of food supply non-availability of desired types of work trouble from feudal and some other social factors. Similarly, easy availability of jobs, higher wage rate, presence of relatives and friends are regarded as major pull factors. The study includes impact of emigration on demography, politics, education and society. The study concludes that in Bombay emigration go back to 1885 and emigration is concerned with young males.

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Some Theories Explaining about the Labour Migration

1. Network Theory

Migrant network play an important role in international labour migration. The process of migration is certainly facilitated through the information provided by relatives and friends, and inter-linkage between sending and receiving countries (Boyd, 1989, pp. 661).

Network access contributes to sustain international labour migration. This may ultimately result in a "Culture of migration" in which travel is expected as a rite of passage for young men and women. It is believed that migration brings maturity on an individual involved. Such culture may create virtual " migration industry: of agents and organization (Lewllen, 2002, pp132). Migration mediated by network occurs when someone opens a path of internal or cross-border migration that is followed by other family and community creating network that increased in complexity over time. (Lewellen, 2002, pp 132).

International relationship based on the ties of Kinship, friendship and shared community creates contact between migrant and non migrant. This contact helps to provide th4e migration flow working as the stimulating factors to primary impetus of migration. It lowers the monetary costs and risk of international migration (Massey et. al. 1993: 448-49).

Thus, above all theoretical aspects on migration shows that the access of good network reduces the monetary and psychological costs of migration ,place of destination and employment opportunities. But, this theory does not explain about the free choice of migrant in terms of destination and types of Jobs. In this regard personal capabilities, risk bearing capacities and skill are also very important in determining international labour migration.

2. Social Capital Theory

According to the theory of social capital migrant network is used as a means to accumulate

financial capital that is further used to acquire social capital (Haug, 2000 and Wyss, 2003). Social capital is an ability to command scarce means by virtue of membership in social structures. Society always requires services from the side of its member. So that financial gain achieved by an individual has to be parted within the community. Thus, social prestige is concerned with performed services by an individual in the community made possible by achieved financial gain with the help of social capital. The social capitals are value introjections, reciprocity exchanges, bounded solidarity and enforceable trust, which are not only influenced by the strength of tie but also by the oriented of the individual (Wyss, 2003. Pp (28-29). It is also considered as collective expectations that effect economic behavior of an individual (Wyss, 2003 pp28). Social capital is not there in the possession of an individual but in the society (Haug, 2000. pp22, in Wyss, 2003 pp28).

3. Migration Systems Theory

Social network between migrants and nonmigrants is certainly a unit of analysis in the migration systems theory (Boyd, 1989. pp661). The exchange of capital, goods, services, information and people has been a common phenomenon in the present day world, although it is relatively intense between some countries and less intense between others (Fawcett, 1989. pp673). Different counters and societies are liked to each other though the exchange that it plays crucial role to build migration system among the countries with the large flow of migrants (Wyss 2003. pp32). Living across borders, international breaks down the identification of nation and state (social space) and give rise to the paradoxical concept of deterritorialized space (Lewellen 2002. pp152).

Novel type of migrant a hybrid combination of both home and host is created and consequently interstate interdependence becomes increasingly independent, as migrants gain knowledge and acquire cultural capital, and social network are reformulated and expanded. As a consequence of high intensity of ongoing socio-economic interaction made possible by cheap and rapid





travel and communication lives are lived across the borders (Lewellen 2002. pp152).

Geographical proximity is no precondition for counters to form migration system that regulates itself with feedback and adaptive mechanism (Massey et. al 1993. pp454). When significance numbers of migrant workers are engaged in particular types these jobs become socially labeled as immigrant jobs, which certainly reinforce the structural demand for immigrants (massey et. al 1993. pp453). Hence, immigrant workers become the eminent part of the receiving society to perform certain roles. These facts favor and encourage the migration process.

4. Flow of Remittance

A study conducted by Yamanaka (2002) reveals that the long standing Gurkha Army Service throughout ht e world has created distinctive "Culture of Emigration" and remittance economy in the rural villages of Nepal. Consequently transnational information network has been created and sustained which has contribution to facilitate the increasing international labour migration though the dissemination of information regarding the employment opportunities and immigration regulations in the receiving countries. At the same time a study conducted by Dixit et.al. (1987) suggests the remittances of migrant labour make a singular contribution to the national economy.

A study conducted by Graner and Karmacharya (2001) suggests the crucial role of remittances at household level. Rural households are supported from various sources of remittances. Value of remittances ranges from an annual average of 8000 (for far west) to above 30,000 NRs (In Kathmandu). Remittances from foreign countries come mainly from India. It has been easy due to the regional inter-linkage of origin and destination places.

Research Methods

This research was carried out within two districts (Doti and Kanchanpur). For this, selection of the area has been carried out at Four (4) VDCs of Doti

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(Mudhbhara, Tijali, Pachnali and Mudagaun (which are merged with in Shikhar Municipality) and 2 municipalities in Kanchanpur Punurbas and Mahakali (then Dodhara and Chandani VDC). This research had carried out into three sections. One in Doti district (Shikhar municipality) and two in Kanchanpur district (Mahakali and Punarbas municipalities). 100 HHs from random sampling method were selected in each clusters. At first, 3 enumerators from concerning areas were hired and made orientation. Then they were mobilized to each cluster. Primary data were collected by Questionnaire methods. Enumerators visited to households and collected data by depth interview method. Respondents were selected as household level (migrants' family, returnee migrants)

Furthermore, researcher himself visited to all study areas to verify the collected data. In depth interviews were carried out as samples of the research. Descriptive as well as explorative research design has carried out during the research process. On the basis of nature, both qualitative and quantitative data were concluded. Mostly, primary data was collected and analyzed. Furthermore, field observation with focus group discussion (FGD) was also carried out in each location. After collection data, it was analyzed with its descriptions.

Analysis and Discussion about the current scenario of the migrants and their families

Most of the migrants' families did not seem to be satisfied with their job in India. The livelihood condition is still not better though they have been working for a long time. Similarly, they did not have alternative opportunities in origin and hence they use to go India for fulfillment of their basic needs. In average, 500 people go to India daily from Gaddachouki boarder only.

Population Coverage and Caste/Gender

Research shows that the male migrants migrated to various destinations from Doti whereas a small



number of females from Dalit and Janjati communities migrated from Kanchanpur district (14.58%-Dalit female @Mahakali and 10.64%-Janjati@ Punarbas). In the focus group discussion with stakeholders, it is also found that few females migrated to India with their husbands in both of the districts. Females from hilly region themselves are not found to migrate for searching opportunities whereas the females from Janjati community are found migrated abroad for job opportunities.

Fig-1: Caste/Ethnicity description with municipalities



Source: Bhatt, 2018 (Field Visit)

Fig-2: Population with Gender



Source: Bhatt, 2018 (Field Visit)

Population by age group and experiences in destination

In case of the Punarbas municipality, about 39.39% Dalit migrants were migrated to India whereas the people from the Janjati community (66%) were found migrated to third country. About 10% of Dalit migrants are found migrated to third country. About 41% of the people go to destination having the age between (25-35) years

and 55% of the total migrated workers have (1-5) year experiences in foreign employment. 52.94% of People belonging to Dalit community and 41.17% of Chettri community have more than 10 years experience in foreign employment. Similarly, 34.42% of Dalit, 49.18% of Chettri, 16.39% of Brahmin of Shikhar municipality of Doti district are found to migrate to India whereas 7.69% of Dalit, 79.48% of Chettri, 12.82% of Brahmin are found to migrate to third country. It is analyzed that the most number of the people from dalit community in Shikhar municipality of Doti district migrated to India than third country.

It is because of their economic condition and lack of access on awareness. In case of Mahakali municipality, the larger numbers of age group under the (25-35) are migrated to different destination. Similarly, the age group under (15-25) shows 36% and above 45

year shows 2% only. Baseline showed that 3 female out of 12 and 4 female out of 36 migrant people belongs to Dalit community are found to migrate to third country and India respectively. Most of

the people of this region migrated to India than third countries.

People having good capacity, skills and knowledge, access on facilities and have economical sound are found to go abroad and they earn good sum of money and the people who are economically poor and far from the access migrate to India only. They earn less money in

comparison to others. Survey showed that the people from these communities are found to stay at destination for long time and it is assumed that most of the migrants might have left their origin in their early age. Furthermore, lack of opportunities in the origin and their poverty is the main cause of long stay in destination of these communities.

Cause of Migration

According to their family members, there are various causes of migration. People are found to





migrate for their survival and they do not have the employment opportunities in local areas. According to field survey, about 33% of migrants are found to migrate for returning the debt. People at local level are used to borrow cash for fulfilling their livelihood activities and finally they decide to go to India or third country for searching job so that they could return the money. About 36.66% of the migrants are found to migrate for searching the job opportunities in destinations. broker, 41.33% by their relative supports and 1% collected with the support of N/GOs. Similarly, about 39% of the total migrants do not have idea about the information collection. They do not know about the man power companies and other means of information on foreign employment.

Cause of Selection of destination

About 44.33% of the migrants selected their



Fig-3: cause of leaving origin

destination because they feel easy to connect with their relatives. 25 % feel easy access to go and less expensive to reach the destination where as 11.66% of the migrants were found to select their destination for earning more money.

Fig-4: Cause of selection of destination



It is equally important to know about the

destination so that they could make plan for their settlement and opportunities there. But the survey data shows that 74.33% of the migrants were not pre-informed about the destination. They selected their destination without any pre information and plans. Among these people, the people of Terai belt are found a bit aware in comparison to the people of hilly range.

Information about the Destination (before visit)

Information collection about the process of foreign employment

Most of the people collected the information about their destination from the support of their relatives and friends. Survey showed that about 6.66% of migrants collected information about the destination through employment companies, 12 % by the help of



Keeping Documentation

Migrants must keep the necessary documents (company name and address, phone numbers, citizenship card number, photocopies of certificates, Visa, passport, photos, about the person with whom s/he stay etc..) concerned about their destination at home. It would support the family for the inquiry about their destination and nature of job. Survey data shows that 20.66% keep documents, but very limited documents. Remaining 79.33% of total migrants do not keep the necessary documents with them and their families too. It is found that most of the people are not informed about the importance of documentation before leaving the origin.



Discrimination from Society

Baseline survey showed that of 6.66% migrants' people only feel that they are socially discriminated because they remained away from the society and about 93.33% of the migrants are

found feel free from social discrimination. During the FGD, most of the migrants' families show their confidence and they were found empowered. They were socially empowered and hence they can raise their voice in the society.

Status of monthly income (According to their family)

Most of the migrants have earned (10-15) thousands per month. About 46.66% of migrants from the sampled area earned (10-15) per month. Similarly, 14.66% earned less than 5 thousand, 27% earned (5-10) thousand per month and 10.33% earned more than 15 thousand per month. it is found that half of the total migrants earn (5-10) thousand rupee per month. It is the few percentages of people who earn substantial money for them. Within the less amount of money, it is hard to make survival of their family. For earning good sum of money, migrants should have the skills, patience, education and awareness. In group discussion, it is found that the migrants did not stay long time in a single location/company. They did not get appointments and had not any kinds of compulsion to stay in single company. They were searching better chance of earning and hence could not stay long duration.

Planning of utilization of remittance

Before going abroad, about 55.66% of migrants were simply planned to utilize their remittance whereas 44.33% had no plan for its proper utilization. But in practical, most of the migrants utilized the remittance for the fulfillment of daily needs. Survey showed that 13.33% remittance was spent on education/health, 63% on food, shelter and cloths, 21% on house, land and ornaments and 2.66% of remittance utilized on entrepreneurship work/business.

Fig-5: Utilization of remittance



Case Registration of Cheating in Foreign employment and human trafficking

During the travelling period and even in destination, migrants are facing several kinds of problems and challenges like cheating, biting, robbery, looted and etc. Due to the problem, migrants are being harassment and become weak. Most of the cases are not registered for getting justice and people are not found aware about it. Baseline survey showed the result that 99.66% of migrants have not idea about the registration of cases.

Bank account and medium of remittance collection

About 81.66% of the migrants do not have their own bank account. Data shows that 18.33% of migrants have only their bank account. According to baseline done earlier, about half of the total migrants are collected remittance with them when they returned. About 14.33% of the migrants collected their remittance through banks, 17.33% through IME and 18.66% through friends/





relatives. It is found that the people still do not use the bank channel for collection of the remittance. In the case of India, most of the migrants bring money with them when they returned or they send money with their friends/relatives. It is because of the lack of banking facilities in their local area. Furthermore, In the group discussion with migrants' family in Mahakali municipality, it is found that the people use bank account of other elite/non related person so that they can collect remittance but they should pay (10-20) % of total collecting remittance.

Participation on the program (Issue related to human trafficking) and social institutions

It is showed that about 95.33% of the total migrants are not found to participate in any kinds of social and human right issues. Most of the people are very far from these kinds of interactions, involvements on rally and social campaigning related to human trafficking and migrations. Only 4 % migrants are participated on interaction programs where as 0.66% migrants follow the social campaigns. According to survey data, only 2 % of migrants from Mahakali municipality participated on social campaigns and 12 % are participated on interaction program related the issue on human trafficking. In case of Shikhar and Punarbas municipalities, 100% of the migrants did not take any kinds of participation on society.

Similarly, very weak participation of migrants in social institutions is found in project sites. Participation on the positions of VDC, municipality, ward level, settlement level, social club, temple, users groups etc were not seen during the field level. Only 15.33% of migrants are found to participate on social institutions but they secured the lower positions only. They are not found in decision making process and do not see their involvement in upper position of the institutions.

Role of Government Organization and Media Mobilization

During the field visit in baseline survey, it is equally observed that the government activities done in the field of foreign employment and human trafficking. There is not found the allocation of budget to address in this sector. The government agencies have not worked directly in these fields till now. But the government has supported the program through other agencies. Staffs of government do not have knowledge and they didn't get any kinds of trainings/orientation in concerned sector. But they are ready to play the positive role to address the issue in coordination with concerning stakeholders.

The hoarding boards with message on these issues are found in some limited places of the town areas. The media did not pay much interest on this issue however; sometimes we get news on the newspaper/FM in these issues. The Media conveys the message through different ways either only on the special occasions or programs by the other supported agencies (sponsored). If there are big issues or big event take place, the media becomes active to publish the news.

Challenges/Problems in foreign employment

A big number of migrants are facing different problems and challenges from the day they started their journey for destination. These migrants are troubled in the transportation, looted in the buses and stations, cheated during the travel, boarder areas (while going/returning to India), cheated at work station and cheated differently in different places. Furthermore, they are cheated in the visa process, and they are not given the promised salary and committed works at destination. According to Survey data, about 17.33% of migrants are well known about the matter of challenges. Similarly, more than half of the total migrants had little bit information about the upcoming challenges in foreign employment where as 31% of the migrants did not have any kind of knowledge on it.

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Conclusion and Recommendation

Based on the findings of research report, following activities should be addressed for safe, prestigious and managed foreign employment:

- Government should take initiation to make the sound polices and monitoring the activities done by concerning stakeholders closely.
- The migrant's from Dalit community migrated to India and earned less amount of money. They are socially and economically poor. So government and other concerning agencies should make the proper programs to aware them and make them strength.
- Information centre should be kept in possible boarders, location and areas.
- Migrants must keep the necessary documents (company name and address, phone numbers, citizenship card number, photocopies of certificates, Visa, passport, photos, about the person with whom s/he stay etc..) concerned about their destination at home.
- Literacy training should be conducted in each location so that the migrants can utilize the remittance in proper business.
- Participation of migrants on social institution should be raised so that they can able to address their issues.
- There should be made a network that can help to make the good relationship in the border areas and if needed, rescue is done through this network immediately. Furthermore, it will also support to reduce the human trafficking, Cheatings, Harassment, Robbery, Rape and other kinds of Crimes.
- Different interaction program should be conducted among the migrant's societies.
- Migrants believe on their relatives and with recommendation of them, labour market (destination) is fixed. So, government or the concerning agencies should support to search

the economical and viable labour market for migrants.

- Government should manage the records (system of keeping proper data for Migrants) with support of local government and local organizations.
- There should be coordination between Nepalese and Indian government for the management of opening the accounts in Indian banks.
- Life insurance for migrants towards India is must. This will make easy to collect the relief fund if any kinds of accident happened.
- Concerning agencies should do proper advocacy for getting appointment letter of the employee. This will support for job security.
- Record of MATE (main person who take the employee from origin, in case of India) is important. it will support to search the missing
- Various Programs (Income Generating, Skill Development, and Entrepreneurship Development) should be launched for returnee migrant workers.

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AN ANALYSIS OF THE ENGLISH TEXTBOOK "THE HERITAGE OF WORDS"



1₩с

Om Prakash Pandey

Abstract

The purpose of this article is to do a comprehensive review of an academic textbook "The Heritage of Words" which is prepared, designed and prescribed for the students of grade twelve of higher secondary level (of that time) in Nepal for the purpose of making students acquainted with different aspects of literature. The author hopes that the readers of this article will have an overview of the textbook along with its positive and negative aspects from various angles.

Key Words: textbook, heritage, literature, pedagogical

Background of the Study

It has been widely accepted that a textbook is an essential component of the classroom. It is the most useful source of information and teaching material in case of unavailability of other supplementary teaching materials. In other words, it is the mostly used teaching material in teaching learning activities in the world as well as in Nepal. It can be taken as a bridge to connect the teachers to students in the classroom. Pointing out the importance of textbook Harmer (1997, p.257) says,

A textbook has obvious advantages for both teacher and students. Good textbooks often contain lively and interesting materials; they provide a sensible progression of language items clearly shaving what has to be learnt. So, the students can revise grammar of functional points that they have been concentrating on.

To evaluate, a textbook is a Herculean task. Commenting on a textbook compiled by the topmost professional writers is not an easy work rather it is very risky and challenging. A researcher must be mentally and physically prepared to conduct such tasks. It needs a great dedication, seriousness and resourcefulness to complete the activity. An immature or careless study may leave harmful effects to all those who are directly or indirectly related to the particular textbook. Considering the vitality of the subject, the researcher should be cautious and try his utmost to maintain the accuracy, preciseness and clarity of its findings.

An Introduction of 'The Heritage of Words'

Edited by the renowned professors of Nepal: Prof. Shreedhar Lohani, Pro.Rameshwor Adhikari and Pro.Abhi Subedi, 'The Heritage of Word' is an academic textbook prescribed as compulsory subject that is directly related to the millions of students of grade 12 in Nepal. Oxford Advanced Learner Dictionary of Current English 7th edition defines the word 'Heritage' as "the history, traditions and qualities that a country or society has had for many years and that are considered an important part of its character" and a 'Word' as "a unit of language or expression". To conclude both of the words 'The Heritage of The Words' means the literature that expresses history and traditions. In other words, it is the compilation of literature that represents our history, traditions or culture.

'The Heritage of words' is the textbook prepared, designed and prescribed for the students of twelfth standard in Nepal for the purpose of making students acquainted with literature. Firstly, it was launched by T.U. in the Proficiency Level as a course book in

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1998, later it was followed by HSEB and it was prescribed for grade twelve in 1999. The objectives of the higher Secondary English are mentioned below (H.S.E.B. New Syllabus (2060/61 courses of study):

- To give a short termed or link course as a kind of bridge or refresher course between English at the secondary and higher levels.
- To teach English for functional, academic and communicative purposes.
- To provide students interesting material for information, knowledge and pleasure.

At present students need a good understanding of the English language to get success in every sector, because English is now considered the primary language for international communication. Lohani et al. (1998) says "The objectives of this selection, The Heritage of Words, is to help readers to acquire sensitivity and involvement in the act of the reading, and look at both the abstract and tangible aspects of life with insight and understanding."

According to Conklin and Newport (1999), the objectives of this textbook are, generally, as follows:

- Students should gain a basic understanding of the texts and should be able to answer comprehension questions about them.
- Students should be able to analyze the style of the texts and should be able to answer questions on language and vocabulary use and linguistic device.
- Students should be able to relate the texts to their own experiences. They should be able to answer open-ended discussion questions which require them to use their own experience and analytical abilities.

Significance of the Study

As mentioned above, the study attempts to analyze the textbook 'The Heritage of the Words' prescribed for 'Grade Twelve'. In the new era of globalization, the importance of learning foreign language; especially English is increasing day by day. So, to involve in the main stream of development, the government should be aware



| A | Synopsis | of | the | English | Textbook | 'The |
|---|--------------|-----|-----|---------|----------|------|
| Η | eritage of V | Vor | ds' | | | |

| Name of the Textbook | The Heritage of the Words |
|-------------------------|---|
| Editor | Shreedhar Lohani, Rameshwar Adhikary and Abhi Subedi |
| Publisher | Ekta Books, Thapathali,Kathmandu,Nepal |
| Printed at | Monaj Offset Press Pvt.Ltd. Ktm. Nepal |
| ISBN | 99933 1 230 4 |
| Binding | Side Stitched |
| Total Unit | 8 |
| Total Lessons | 23 |
| Total Pages | 178 |
| Price | NRs. 195 |
| First Edition | 1998A.D. |
| Thickness | 1cm |
| Margin | Top 1.3cm, Bottom 2cm, Right 1.5cm |
| Size | 21.5cm×14cm |

Analysis and Interpretation

Analyzing a textbook from only one aspect is always incomplete; it should be analyzed from the multiple angles from different aspects. To make the chapter more convenient, this chapter is parted into two major sections. The first section deals with the analysis of the academic aspects where as the latter one is concerned with physical or peripheral aspects of the textbook.





1. Analysis and Interpretation of the Academic Aspects

'The Heritage of words' is taught to the students of grade twelve of higher secondary level along with another textbook 'Meanings into Words' with the purpose of making a perfect combination between language learning and literature. The study of the English language is complemented by a study of English literature because reading literature broadens a student's knowledge and understanding of the wider world. 'The Heritage of Words' aims to introduce students' wide range of texts, to teach students the essential elements of textual analysis and to equip students with critical thinking skills.

According to the curriculum published by HSEB in 1996, 'The Heritage of Words' constitutes 40% of the grade 12 compulsory English course. It contains 23 texts divided into eight thematic units. The first seven sections contain 5 poems, 4 stories, 6 essays and 1 play. Each unit has a clear thematic content and all the eight units together present an intelligent treatment of important ideas and topics of present day relevance. Not only is that, before every text a short biography of the particular writer is given, for the purpose of introducing the readers about the related writer of the text. As described by the Lohani et.al. (1998) unit one 'Love and Reminiscence' motivates the readers to the dynamics of romantic love almost at platonic level: love dipped in reverence for one's grandmother; love for bygone youthful days and feeling of loss in the present. Unit two 'Ecology and Change' delivers the massage about the impacts of environmental degradation. It informs the readers how the destiny of human beings and other creatures are tied up with the nature and its conservation. Unit three, 'Humor and Satire' portrays two different images of the society through the eyes of two boys. A boy quietly but critically examines the adult world and another one is compelled to come out of the boyhood to the manhood to prove himself right. Unit Four 'God and Man' introduces the greatness of God and nature as a gift of God to the people. Unit Five 'Human Rights' introduces the very

famous American human rightist leader Martin Luther King's strong appeal for humanity and human rights. Unit six 'Women and Children' inspires the readers by telling the story women's search for identity, similarly it tells about the changing attitude of society towards the children and women as well as the sociological differences between east and west. Unit Seven, 'Crime and Confession' presents two different stories of crime and assumes that confession of the crime leads to the purgation of the sin. The last but not the least is 'Playing with the Text' which contains several versions and interpretations of one very famous folk story introduces a very strong method of showing how successive texts are built up in the process of transfer and reinterpretation. Moreover, it shows how different possibilities interpretation of a text are overlooked while reading it.

a) An Overview of The Textbook from Literary Point of View

From literary view point the proposed textbook can be mainly divided into four branches.

i) **Poetry:** There are mainly five poems written by different poets, collected in the book. The main purpose of this section is to introduce the students about the poetry and make them acquaint with the various techniques of poetry. These poems are put in different units of the textbook. The topics of the poems are mentioned below:

Topics

- <u>Page No.</u>
- 'The Grandmother' by Ray Young Bear 11
- 'The Lamentation of the Old Pensioner' by W.B.Yeats 25
- 'Full Fathom Five Thy Father Lies' by William Shakespeare
 37
- 'Travelling Through the Dark' by William Stafford
 43
- 'God's Grandeur' by Gerald Manley Hopkins 69

ii) Prose/Essay : There are eight essays collected in the book. Some are comparatively easier where as some are rather difficult. Some of the essays prescribed focus on current problems of the society where as some are historical. The headings of the essays are as bellow:

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Topics

Page No.

- 'The Two Long Term Problems:
- Too Many People, Two Few Trees' by Moti Nissani
 29
- 'Hurried trip to Avoid a Bad Star' by M.Lilla and C.Bishop Barry
 39
- 'I Have A Dream' by Martin Luther King, jr. 73
- 'Women's Business' by Ilene Kantrov
 83
- 'The Children Who Wait' by Marsha Traugot 90
- 'A Child is Born' by Germaine Greer
 97
- 'Gretel' by Garrison Keillor
 148
- 'Hansel and Gretel' by Jack Zipes 166
- 'Hansel andGretel' by Bruno Brettelheim 168

iii) Fiction: This book introduces some fictions too. It does not contain easy supernatural stories as in 'The Magic of Words', its preliminary series. Instead, it consists of some psychological and psychoanalytical stories that are very difficult to understand for the low level students. Moreover, it consists of one very famous tale 'Hansel and Gretel' and its various interpretations to teach students about adaptation or inter-textual relationship. The titles of the stories given in the textbook are:

<u>Topics</u>

<u>Page No.</u>

- 'About Love' by Anton Chekhov
 13
- 'A Story' by Dylan Thomas 47
- 'The Last Voyage Of the Ghost Ship' by G.G. Marquez 58
- 'The Tell-Tale Heart' by Edger Allan Poe 109
- 'Hansel and Gretel' by Jackob and Wilheim Grimm
 130
- 'Gingerbread House' by Robert Coover 137
- 'The Little Brother And Sister' by Jackob and Wilheim Grimm
 151
- 'The Boarding House' by James Joyce 156

iv) Drama: Drama is also one of the most important genres of literature. In other words the study of literature remains incomplete without knowing about drama. As the curriculum aimed to introduce the students about drama and its

basic components, it has included a drama in its courses of study.

<u>Topic</u>

- Page No. 116
- 'Purgatory' by W.B.Yeats

Conklin and Newport cite (1999), '"The Heritage of the Words' presents teaching with many new challenges. Many of the texts are long and will be found very difficult by the students". To sum up, 'The Heritage of the Words' is a tasty sausage that gives the taste of all the spices of literature. It is a complete package of the literary texts for the students of Grade twelve.

2. Analysis and Interpretation of the Peripheral Aspects of the Textbook

If the academic aspect is the soul of a textbook, the peripheral aspect is the physique. We know that both are essential to form a living being. Generally the physical/ peripheral aspects represent the layout of the book, binding, printing, paper quality, pictures and illustration, pricing and availability. The physical aspects of the textbooks are systematically presented here below.

i) Layout of the Textbook

The cover page of the book has mixture of white and blue background. The heading of the book is written in stylish bold letter in blue colour. A cylindrical shape, having all the colours of rainbow is on the middle of the cover page. At the top of the figure, seven units of the textbook are written. On the body, all the four genres of literature: Poem, Story, Essay and Drama are written very stylishly. It symbolizes that the textbook prioritizes all the forms of literature. The names of the three editors of the textbook are written at the end of the front cover page. The back cover has purely blue back ground. The cover page is semi hard; however the binding of the textbook is qualitative. The students can use it throughout a year without any damage in its binding. The role of the size of the textbook is also vital. If the book is bulky in its size, it reduces the use of the textbook. To talk about the size of this book, it is very proper.

To sum up, the outlook of 'The Heritage of the Words' is average, the cover page is all right, the binding is good and size of the textbook is apposite.

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ii) Printing and Paper Quality

The font size, printing quality and quality of paper are equally important factors for the excellence of the textbook. Talking about the proposed textbook, the size of the font of the textbook is tolerable; however the introduction about the writers written before every text is comparatively printed in smaller font size. That's why it gives a lot of stress to the eyes. The printing quality is satisfactory. The paper used for the textbook is neither of an excellent quality nor bad.

In conclusion, the textbook is average in terms of its font size, paper quality and printing.

iii) Pictures and Illustrations

Proper use of pictures and illustrations makes the textbook more virtuous. It allures the readers towards the textbook. But there is no use of pictures in 'The Heritage of Words'. The textbook is blank from the view point of pictures and illustrations.

iv) Pricing and Availability

As 'The Heritage of the Words' is a compulsory subject, it is used by all the pupils either they are having higher economic status or poor economic status. So, it must be affordable for everyone and it must be accessible to everyone.

The textbook cost 90 NRs at the time of publication but now the price has been updated to 195 NRs. Thus, this price may be a bit much for the poor class but it is not so high for most of the pupils. To talk about the availability, the textbook is printed by Ekta Books, Nepal. So, it is easily available in those areas of Nepal which are accessible from the transportation view point. Concluding, the textbook is average in terms of pricing and availability.

Conclusion

To sum up, The Heritage of Words can be given average marks in terms of its physical qualities. But how far the academic content concerns, the textbook is below average because of its outdated contents. J. Harmer (2001) has proposed the following criteria for a textbook evaluation:

Price, Availability, Layout and Design,

Instructions, Methodology, Syllabus type, selection and grading, Language study activities, Language skill activities, Topics, Cultural acceptability, Usability, Teacher's guide (p.301)

However, the main quality of the every textbook is to enhance the knowledge level of the students. Unless the textbook meets the need or standard of the students, they are not supposed to be quality textbooks. To meet the changing demands of the students, the textbooks need to be revised and updated time and again. Hence, it is the main loophole of the textbook. From the above review, it becomes crystal clear that the book was published 20 years ago and has not been revised yet. The contents, which seemed appropriate in the academic or sociological situation of twenty years ago, may not be appropriate in today's context. On the other hand the book seems weak in terms of cultural acceptability, language skill activities too.

(The writer submitted a thesis on this topic in 2013 A.D. to the Department of English Education in partial fulfillment for the Master's Degree of Education in English and the detailed copy of research along with the data collected is safe in the library of T.U. for the further details.)

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Post-partum family planning: a hidden public health agenda



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Abstract

Post-partum family planning is prevention of unintended pregnancy and closely spaced pregnancies through the first 12 months following childbirth. Fertility is not predictable after child birth and post-partum family planning provides choice and options concerning future pregnancy and family size. Maternal newborn and child health workers are the key service providers for post-partum family planning and methods that are compatible with breastfeeding need to be considered. Different contraceptive methods can be used safely during post-partum period and timing of initiation is the key.

Key words: Post-partum family planning, Fertility, Integration

Definition

Postpartum (PP) period starts one hour after the delivery of the placenta and includes the first six weeks after childbirth. A birth interval (or "birth-to-birth") is the length of time from the birth of one baby until the birth of the next baby. The interpregnancy interval (or "birth-to-pregnancy") is the length of time from the birth of one baby to the conception of the next baby. Healthy spacing of pregnancies should be at least 24 months (i.e. time period before attempting next pregnancy) in order to reduce the risk of adverse maternal, perinatal, and infant outcomes. However, after a miscarriage or induced abortion, spacing should be at least six months. Postpartum family planning (PPFP) is defined as the prevention of unintended pregnancy and closely spaced pregnancies through the first 12 months following childbirth [WHO].

Fertility Return

The return of fertility is not predictable. Fertility may occur soon after birth among women who are not breastfeeding. Women who are not breastfeeding regularly (exclusive breastfeeding) are likely to ovulate before the return of menstruation. It was found that almost 71% of non-breastfeeding women ovulated prior to return of menses and up to 60% of these ovulations were potentially fertile (Campbell and Gray 1993; Jackson and Glasier 2011)

Pregnancies within the first 12 months after a birth—in other words, a birth-to-pregnancy interval of less than 12 months—are at highest risk for adverse health outcomes to the mother and child; are much more likely to end in potentially unsafe induced abortion; and are at elevated risk for stillbirth,

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preterm birth, low birth weight, and small size for gestational age. Closely spaced births are also correlated with increased likelihood of chronic undernourishment, stunted growth, and infant mortality. Because of these serious health risks, spacing pregnancies at least 2 years apart can avert an estimated 10% of infant deaths and 21% of deaths in children ages 1 to 4 globally [Gaffield, Egan and Temmerman, 2014]

Importance of PPFP

As return of fertility is not predictable, post-partum family planning is very essential and it provides choice and options concerning future pregnancy and family size. It also supports to have better education, employment, economic well-being and rest from demands of frequent pregnancy and child bearing [Fig 1]. Fig1 Importance of PPFP



Postpartum family planning not as usual

Postpartum family planning can certainly be provided as part of a comprehensive family planning program. However, it has several unique elements that make it different from "family planning as usual." Postpartum women are not always aware that they can become pregnant and they can have unprotected sex. Woman not breastfeeding can become pregnant within four to six weeks after childbirth. Usually family planning service is provided by family planning workers. But maternal newborn and child health workers are the primary service providers for post-partum family planning and they need to consider methods that are compatible with breastfeeding [Fig 2].

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Fig 2: PPFP not as usual



Integration of family planning during post-partum period

There are many opportunities for providing postpartum family. Antenatal care (ANC), Post natal care (PNC), delivery, immunization, child care, Prevention of mother to child transmission (PMTCT) services are the best possible occasions to provide post-partum family planning services .When any of these opportunities is missed, a woman who wants contraception (or having unmet need of family planning) may not have access to family planning services. It is best to begin family planning counseling during pregnancy, then during childbirth to initiate certain feasible methods and then during postpartum period to offer the family planning methods. But voluntarism and informed choice of the clients should be considered while offering family planning methods. Therefore, post-partum family planning should be a routine part of maternal, newborn, and child health care across the continuum of a woman's childbearing cycle [Fig 3].

Fig. 3 FP Integration during post-partum period



Contraceptive Methods for the Postpartum Woman

Different contraceptive methods are available for postpartum period and most of the methods can be used safely whether or not woman is breastfeeding. But, timing of initiation should be taken into consideration. Combined estrogen-progestin contraceptives are not initiated until three weeks postpartum [Fig 4].





Fig: Post-partum contraceptive options



Conclusion

It is best to begin PPFP counseling during pregnancy, then during childbirth to initiate certain methods and then during postpartum period. PPFP should be a routine part of maternal, newborn, and child health care across the continuum of a woman's childbearing cycle. Holistic and evidence based PPFP interventions are required to strengthen family planning service delivery system and sustain the quality family planning services.

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A Review on Medicine: Are these enough ?

Human being has survived from the primeval period till now as we evolved from different civilizations. Hence, we can see difference between us. Let's not get tangled in the labyrinth topic of evolution. Medicine was the indispensible component of each civilization. For example, it has been proved without a shadow of a doubt that humans in Stone Age used herbs as medicine. Hindu civilization had Atharvaveda, the Veda among four Vedas that stated about medicine; although most of the content was purely based on exorcism and super natural influence. Ayurveda later bolstered among Hindus with Charaka and Sushruta being the major contributors. Vedas have history of more than 5000 years. Every civilization have their own history in medicine; Egyptian had Imhotep, Egyptian god of medicine, Babylonians had it written in Code of Hamurabi, Chinese are well known for their traditional medicines which are still being used, and Hippocrates in Greece. Greek medical history has sturdy role in the development of western medicine, Hippocrates being the quintessential figure of Greek medicine. Most of these medical practices were based little on herbal medicines and mostly on divine faith.

All above historical approach of medicine have critical role in development of modern medicine. University began systematic training of physicians around 1200-1250AD in Italy. Medical science developed to some extent throughout the Renaissance period with the invention of microscope. Before 19th century, typically whole herbs were used as a medicine, though there has been history of isolation of plant component since the time of Galen. Generally, plant consists of various chemical components; isolation of those components is required for the targeted action.



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First chemical extracted systematically from plant was morphine from the plant opium, then quinine from cinchona bark, atropine from Atropa belladonna soon followed. Synthetic chemicals were also used as medical agents, such as, Ether and Chloroform revolutionized surgery in 19th century. People succumbed surgery due to its excruciating nature and presence of very few anodynes, before ether and chloroform were introduced. Later chloroform and ether both were replaced by next generation anesthetics due to severe liver toxicity and flammability nature of chloroform and ether. Phenol was synthesized as first antiseptic agent. People died from pain and infection post surgery before those inventions. Mortality decreased to some extent after development of anesthetics and antiseptic agents. Many organic compounds were synthesized in 19th century; some had very useful activity as medical agents. Most of the discoveries were based on fluke, hunch and educated guess works. Scientists then emended their work and work of their colleagues to get better therapeutic agents, for e.g., development of acetanilide lead to discovery of salicylic acid to Aspirin and Acetaminophen.

20th century proved to be crucial century for the development of pharmaceutical science. 20th century started with a huge contribution from Paul Ehlrich by developing arsphenamine. Arsphenamine was 606th chemical studied by Ehlrich for the development of anti infective agent against Syphilis. Stupendous revolution occurred

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in the medical science by the introduction of "germ theory of disease" by Robert Koch and Louis Pasteur. The theory gave birth to the branch of science, Microbiology. Later the furtherance of the theory led to the great discovery of Penicillin by Alexander Flemming in 1928. Anti infective/ Antimicrobial agents boomed after the accidental development of Penicillin. 20th century saw lots of improvement in Pharmaceutical science. Vitamins and hormones were discovered in 1940s, most of the vaccines were developed in the period. Some diseases caused huge epidemics throughout the world for e.g. Plague, Small Pox, anthrax, etc but the development of the medical science, one way or other jettisoned them. Another field, where we saw huge development in pharmaceutical science in the period is medicinal chemistry. Though, isolation of lead compound started in late 19th century, it was practically used around 1950s. One of the biggest accomplishments achieved by medicinal chemistry was finding out Structural Activity Relationship. By the use of SAR, numerous anti hypertensive drugs, B-blockers, Anti asthmatic drugs were developed. Later SAR was given numerical value to make it more precise. Drug design concept flourished with advancement of quantitative structural activity relationship. Late 20th century saw progress in digital technologies, which helped to improve the drug design concept with Computer aided technologies. Development of biopharmaceutical science lead to the modification of dosage form, manipulation of the pharmacokinetic properties for more targeted action of drugs.

Thriving of pharmaceutical science in late 20th century was mainly due to commercialization of medicines and establishment of multinational pharmaceutical industries like Merck, Hoffman La Roche, Abbott Laboratories, Eli Lilly etc. Before the industrialization in pharmaceutical field, drugs, medicine was not considered as profit business. Mainly after the 2nd world war, pharmaceutical industries got grab to the world market. High investment was done in pharmaceutical field after 2nd world war because

of foreseen profitability. Then the motive of medicine changed from people to profit. Big companies like Merck, Eli Lily, Novartis, invested highly on research of new molecules. Commercialization of drugs had both pros and cons. We saw huge improvement in research work and development work, easy availability of drugs, development of professional education in the field etc. The cons of commercialization were unethical marketing, rise in the cost of medical supplies, etc. Lately the development of pharmaceutical science has been mainly on the manipulation of the biopharmaceutical properties of the drug molecules known as novel drug delivery system. This system is mainly based on targeted drug delivery which increases the intensity of the drug action concurrently reducing adverse drug reactions. Latest concept of medical sciences include genomics, biotechnology, they deal mainly with the genetic components for proper medical treatment.

So, how far have we really come in this field? We have seen lots of development in medical and pharmaceutical sciences since the beginning of time. We have always depended on these pharmaceutical preparations for improvement of our quality of life, but have we come far enough is my question. Except for Antimicrobial agents, anti cancer agents and few other drugs, have we really seen any curative drugs? Most of the drugs we use today are for symptomatic cure not for the complete treatment of the disease for e.g., Antihypertensive agents, Steroids, Ant diabetic agents, asthmatic drugs, etc. We are still tussling to fight against the deadly Tuberculosis probably one of the oldest known disease. People in South Asia and Africa still die of tuberculosis in large number, despite of various pharmaceutical companies of these nations including Nepal manufacturing effective medicine. Maybe the big buck pharmaceuticals are mainly oriented towards the disease spread in the 1st world. That's not the case either. Top killer diseases in 1st world are Hypertension, Diabetes, Cancer, Asthma, Gastro intestinal diseases. Do we have proper curative answer against any of those diseases? The

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answer is big NO. This give rise to a big question, what have we really developed with the aid of such modern sophisticated technologies? Are we investing our time, energy, knowledge resources in the right path? . Even

It's not that we haven't done anything at all, we have improved cancer therapy, we have prolonged the life expectancy by large number, we have improved quality of life of people with all these available medicines, we have developed first vaccine against cancer causing agent (HPV), etc. Are these stuffs actually enough? Probably not, we aren't searching for the panacea, but we definitely deserve more in the field of pharmaceutical science.

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