

Chapter-I

INTRODUCTION

Background of the Study

The history of mathematics is interrelated with the history of human civilization. Mathematics has become an integral part of the modern world in turn valuable to all other branches of our cultures. Every culture has developed some mathematics. In some cases, the mathematics has spread from one culture to another. It is claimed that the first mathematics originated around five thousand years ago along with the ancient Egyptian civilization, Babylonian civilization, Greek civilization, Chinese civilization, Hindu civilization (Boyer, 1968). Thousands of years ago there were no numbers to represent two or three. Instead fingers, rocks, sticks, or eyes were use to represent numbers. There were neither clocks nor calendars to help keep track of time. Evidences of the fact that mathematics developed in culture and civilization spread into another culture and civilization can be found everywhere.

Now a days in the field of mathematics there are many works, which are sufficient to fulfill the demands of 21st century in the mathematical field. The history reveals that the number and counting system have developed before the recorded history of human civilization. Ancient counting system was beginning with the concept of more and less. In primitive period, figure, pebbles, sticks, knots were used for keeping count.

The Babylonians, who lived in Mesopotamia, developed a substantial body of mathematical knowledge, well before most other civilizations. The Babylonians system of mathematics was sexagesimal (base 60) number system (Boyer, 1968).

Hindu civilization takes essential role in the development of mathematics.

According to Boyer the civilization of China and India are of far greater antiquity than those of Greece and Rome (Boyer, 1968).

In current situation in the field of mathematics, there are many works which are sufficient to fulfill the technological and mathematical demands of 21st century and many more. It is not declared that who, when, how, why, where the numbers, addition, and multiplication were invented. This operation appeared several thousand years ago, apparently independently, in China, India, Mesopotamia, and Egypt (Cook, 2005).

In the development of world mathematics, Hindu mathematics provided the unvaluable contribution with decimal number system and place value system because this system takes vital role in present situation of mathematical development (Shrestha, 2013). In Bharatvarsa those days Aryabhata, Brahmagupta, Bhaskaracharya, Srinivasa Ramanujan, and Mahavira Acharya were so popular mathematician and wrote many books such as *Aryabhatiya*, *Brahmasphutasiddhanta*, *Siddhanta Siromani*. The mathematical part of the *Aryabhatia* covers arithmetic, algebra, plane, trigonometry and spherical trigonometry. It also contains continued fractions, quadratic equations, sums of power series and table of sines. Mathematician Brahmagupta made one of the major contributions to the development of the number systems with his remarkable contributions on negative number and zero. Next mathematician Bhaskaracharya wrote *Siddhanta Siromani*, *Lilawati* and *Vijaganita* are two important part of this book. It contains numerous problems, linear and quadratic equations, Pythagorean triads, both determinate and indeterminate simple menstruation, surds and others. In the second section of earlier portion of Narad

Vishnu Puran (written by Ved Vyas) described which are ten times of each other, in a sequence (10 to the power n). (<http://en.wikipedia>)

Due to the cultural, geographical and religious attachments, Nepalese education system was highly reflection of the education of South-East Asia. Since the development of mathematics of Nepal was carried out from *Vadik* mathematical content. According to Philosophy of Mathematics (Shrestha, 2013) although the almost 3000 years old Vedas are mostly devoted to describing Gods and Goddess, it represents ancient civilization as well as shows the origin of mathematics in such areas like economic policy, algebra, geometry, astronomy and so on. Sulva Sutra was developed in order to systematize geometrical knowledge that was developed from Hindu practices needed in making *Bedi* and fire places (Agnikunda) (Boyer, 1968).

The history of mathematics teaching in Nepal initiated with *Gurukula* in ancient period (Pandit, 2011). The *Gurukula* education system continued for many years and there were no formal schools as we have today's. In this education system in terms of *Jyotisha Shastra*, basic mathematics courses had been taught (Pant, 2004). Teachers teachings Jyotisha were popular mathematics book written in Sanskrita like *Siddhant Siromani* of Bhaskaracharya(II).

Sanskrit school was established in 1877 A.D. and *Sidhanta Siromani*, *Lilawati*, *Bhaswati*, *Bij-Ganita* referred as textbook of those schools (Pant, 2004). Schooling for general people began only after 1951 A.D. when a people movement ended the autocratic Rana Regime (1845-1950) and initiated a democratic system. However, Durbar High School was established as early as 1853 A.D., it was only for the children of Rana Family. This school was the first formal school in the history of education in Nepal and mathematics was taught at that school in English medium.

Jha, Adhikari and Panta stated that about 125 year ago there were no written mathematics books in Nepal (Jha, Adhikari, Pant, 2006). Nepali students in those days used to go to kashi (Banaras) to learn *Sanskrit* and there, they were taught famous books on mathematics like *Siddhant Siromani* of Bhaskaraacharya (II). (Pant, 1980). Nepali students were influenced from Indian mathematician. After returning back, Nepalese students used to teach *Bhaswanti*, *Lilawati*, Algebra, geometry and trying to write books.

The first book of mathematics written in Nepali language is found to be *Wyakta Chandrika* and it was published in 1883 A.D. (Pant, 1980). This book was based on the *Lilawati* of Bhaskaraacharya. The mathematician and teacher pd. Gopal Pande wrote this book. This book contains numerous problems dealing with favorite topics of Hindu mathematics; linear and quadratic equation, geometric, progression, surds, Pythagorean triads, both determinates and indeterminate simple menstruation, arithmetic and geometric progressions and others. His next popular book is “Lokanu Smriti” it deals with a nice explanation of *Loktantra*. Other famous scalars and writers in mathematics were Nuru Datta Pande, Master Merunath Pande, Kabiraj Pande, Ganga Prasad Shrestha (Pant, 1980).

During that time, one Nepali woman Chadrakala Devi Dhananjaya had written a book named *Shishubodha Tarangini* in slokas form, which was published in 1933 A.D. Chadrakala Devi did not have acquired any formal education. However, she wrote such a book, which is still considered most important to study the Nepalese history of mathematics. She is supposed to be the first Nepali woman writer of mathematics book and teacher in Nepal. Until now, no Nepali woman mathematician has been seen in writing mathematics book on single ownership. Therefore, I am much interested to carry out a research work on the given title of this study.

Statement of the Problem

Nepal is legally and functionally a federal democratic republic country. Nepal is, rich of indigenous community. It is obvious that all these communities have some amount of traditional knowledge. In this context, mathematics is main part of our communities. It is necessary in every field. In the development of mathematics, different people have done different works in ancient time to modern time.

In the context of Nepal, women do not seem to be interested in mathematics till present. However it is the great matter for Chandrakala Devi who used to live far away from the capital city of the country and who was brought up in the atmosphere of village for writing the tough subject like mathematics even 80 years ago. She has presented the evidence that even the women can contribute in the field of mathematics by writing the book named *Shishubodha Tarangini* in the history of Nepalese mathematics. It is not a minor task to study, teach and write the tough subject like mathematics for those women who are living in the village in the contemporary time and even by overcoming the family situation of the woman. It is the great matter for the woman to write mathematics when even the male writers were found in very less number at that time. Without taking the formal education, she has written the mathematics subject as well as she has presented mathematical problems and their solution in poetic verse in her book. In her book, it is found lots of content in comparison with the other books written in Nepali language like *Wyakta Chandrika*, *Bichitra Ganit*, *Ganit Sagar*, *Saral Ganit*, *Gorkha Bijganit Shiksha*, *Pati Ganit*. Therefore, she is called the first woman mathematician. While conducting the research of Nepali mathematics writer, so many male writers were found to be researched but regarding the women writers, they were not found to be researched so while conducting the research of female writer, it is conducted a research about the

woman mathematics writer Chandrakala Devi Dhananjaya. Therefore, this research study has sought the answers of the following questions:-

-) Who was Chandrakala Devi Dhananjaya?
-) How did she become a mathematician?
-) What type of book named *Shishubodha Tarangini*?

Objective of the Study

Historical development of mathematics is highly interesting and exciting subject to research. It promotes our interest in mathematics and focuses the contribution of Nepalese people to the development of mathematics, which is used in every steps of our daily life. Every research has its own specific objectives, this study has the following objectives:-

-) To find out the biography of Chandrakala Devi Dhananjaya.
-) To explore the mathematical contributions of Chandrakala Devi Dhananjaya.
-) To analyze content of her book named *Shishubodha Tarngini*.

Significance of the Study

Biography and contribution of Nepalese woman mathematician in development of Nepalese mathematics is highly interesting and exciting research area. It promotes our interest in mathematics and focuses the contribution of Nepalese people to the development of mathematics, which is very important in every step of our daily life. The result of study would help in the following ways:-

-) To promote our interest in mathematics especially in woman.
-) To support the historical development of mathematics.
-) To focus the contribution of Chandrakala Devi Dhananjaya in the development of mathematics.
-) To study the trends of mathematics education of Nepal.

-) It helps to explore for how Nepalese mathematics contents developed and modified.

Delimitation of the Study

The research attempted to carry out the study taking the following delimitations.

-) The research was limited with the contribution of Chandrkala Devi Dhananjaya in Nepalese mathematics. It does not provide detail information about other mathematicians.
-) This study was based on limited sources of information obtained by her family, classmates and various book articles related to *Shishubodha Tarangini*.
-) It focused only mathematical facts, patterns and theory based in *Shishubodha Tarangini*.

Definition of the Operational Terms

Shihubodha Tarangini: - Name of a book written by Chandrakala Devi Dhananjaya, was published 1933 A.D. and contained numbers of problem based on unitary method, HCF, LCM ratio, decimal system, measurement, and others.

Wyokta Chandrika: - Name of book written by Pd. Gopal Pande and published in 1883-1914 A.D. It was first mathematics book of Nepal written in Nepalese language. This book was based on the Lilavati of Bhaskaraacharya.

Lokanu Smriti: - Name of book written by Pd.Gopal Pande and published in 1883-1914 A.D. It deals with a nice explanation of *Loktantra*.

Biography: -Details about the life of a person especially published

Contribution: -Works and masterpieces created and composed on related fields

Script: -Script is a lines or a group of lines that is either derived from resembled letter or from character used.

Manuscripts: - It is the handwritten text recorded on the paper, palm leaf, birch leaf, clothes, etc.

Inscriptions: - Especially a word or words written or engraved on a solid substance for preservation.

Cube Root:-A number that when multiplied three times equals a given number, like 2 is a cube root of 8.

Gurukula: - A type of school Practised in Nepal as well as India, residential in nature, with students living near the teacher, often with in the same house.

Lilavati: - A book written by Bhaskaraacharya published in 12th century contained Bija-ganita, Arithmetic as well as Geometry and calculus.

Jyotisha :- The scientific study of matter and phenomenon in the universe, especially in outer space, including the positions, dimensions, distribution, motions, composition, and evolution of the celestial objects.

Jyotisha Shastra: - A discipline which study about Jyotisha in the universe, especially in outer space, including the positions, dimensions, distribution, motions, composition, and evolution of the celestial objects.

Numeral System:-Word or figure represents a number in numeral. It is the symbol for writing number. The system to express, the numbers using the numerals is known as numeral system.

Contemporary Mathematics: - It refers to the mathematics in general application and can be used anytime, anywhere and regardless of who uses it. In general, business mathematics and mathematics of investment may be well classified under this category.

Chapter -II

REVIEW OF RELATED LITERATURES

History is as a way of motivating the learner to see the significance of the area being studied. We consider to history as a route to help the learner understand the path of development to a mathematical concept or process. History of mathematics is as old as the human civilization. These days history of mathematics is a powerful tool for a disseminating an understanding of mathematics. In this context a review of related literature is sourced for the further study of research task. During the period more than four decades there are some studies done about the Nepalese mathematician. Thus a review of related literature is important and essential role for guideline of research planning. There are few research in the field of history of Nepali mathematics among them some related literatures are described as;

Acharya (2015) studied on 'Studies on Mathematical treaties of Nay Raj Pant'. This study was mainly focused with books written by Nay Raj Pant, contents of his mathematical books and his contribution to develop mathematics. The major findings of the study were:

-) Nay Raj Pant simplified the way of presenting mathematical content.
-) Pant critically analysed previous mathematical works.
-) Pant compared Hindu mathematics with Greek mathematics.
-) Pant continuously studied the history of Nepalese mathematics.

Besides their works, Acharya has find out the hidden facts based on Bhaskaracharya's works. In their research, Acharya has concerned document analysis as the major works with concerning south Asian mathematical developments too.

Kandel (2015) has conducted a research in title "Biography of Bramha Lal Shrestha and his contribution on Nepalese mathematics". The main objectives of this research were to find the biography of Bramha Lal Shrestha and his contribution in Nepalese mathematics. Also main purpose of his research was to explore the mathematical contribution of Bramha Lal Shrestha through his book "Vichitra Ganita". Furthermore, he examined in the wake of the earlier studies of the ancient mathematics especially in history of Nepalese mathematics. The study was done by qualitative design but, study limited about Shresthas's contribution through his publications. This study was incapable to provide brief account of first woman mathematician Chandrakala Devi Dhananjaya.

Khanal (2012) has conducted a research on "Contribution of Nay raj Pant in Siddanta Jyotisha". The main purpose of this study was to explore the mathematical system of arithmetic, geometry, astronomy, trigonometry and others. This was basically related in the biography and contribution in Jyotish of Prof. Pant.

Acharya (2012) has given Prof. Naya Raj Pant's biography, personality and his contribution in Nepalese mathematics in an article, which was published by Ramanuj Society of Mathematics and mathematical sciences. Furthermore, he examined in the wake of the earlier studies of the ancient mathematics especially in astronomy, jyotisha, cube root, trigonometry, sumatitantra and analysis of manuscripts of mathematics. The study was done by qualitative design but study limited about Naya Raj Pant's contribution through his publication and manuscripts. This study was incapable to provide brief history of mathematics books practiced in Nepal

Acharya and Pant (2011) has written an article "Chandrakala Devi Dhananjaya and Shisubodha Tarangini in mathematical history" which basically concerned

biography and effect of this book in this period. Acharya and Pant explained few parts of book “Shisubodha Tarangini” in this article.

Acharya (2011) has conducted a research on “An analytical study of Nepalese history of mathematics”. The objectives of this study were to identify the historical development of mathematics in Nepal. In this research, he has explained developments of mathematics in Nepal in different times, community and regions by Nepalese people using various books, articles, manuscripts, biographies, inscriptions etc.

Acharya, (2009) has written a short commentary “Gorkha Bijganit Shiksha ko Samikksha”. In this commentary he has critically analyzed of the “Gorkha Bijganit Shiksha” written by Nuru Datta Pande. Therefore, the purpose of this article was to explore the mathematical system of algebra in Nepalese context.

Jha, Adhikari and Pant (2006) conducted a research entitled “A history of mathematical sciences in Nepal”. The main objectives of this research were to present a brief historical account of the Nepalese mathematician up to nineteenth century and their remarkable contributions to the mathematical sciences in Nepal. Their work in research had been divided into two parts: historical background and modern period. Historical background includes the survey work of mathematical activities in Nepal during Lichchhabi Era, Malla Era, and Shah Era.

Olsen (2002) has conducted research works “Essays on Georg Rasch and his contribution to statistics”. The main purpose of study was to explore about the Georg Rasch and his theory Rasch models which is a class of statistical models designed for the analysis of questionnaires that he developed and explore the events. This work consists of six self-contained articles such as biography of Georg Rasch, rediscovers

Rasch's work, how Rasch developed the Rasch model etc. and all of them are connected to Rasch and his contributions to statistics.

Prasit (2002) wrote "Bahumukhi Prativa Tika Ram Dhananjaya" which is concerned in the biography and contribution of Tika Ram Dhananjaya in Nepalese mathematics. In this book, Prasit has explained creation and published books of Tika Ram Dhananjaya

Pant (1980) has conducted a research entitled "Pd. Gopal Pande and his method of getting cube root". The main objectives of this research were to study about Pd. Gopal Pande and illustrate his method of getting cube root. In research, Pant has explained new approach of getting cube root of Pd. Gopal Pande. The design of the history was qualitative based. In this research, the data was collected by study of profiles, study of printed and collected documents and counseling with resource persons.

Many researchers have been done in Nepalese mathematician but on the behalf Chandrakala Devi Dhananjaya only little information has been given by S.R Pant and E.R Acharya. The information, which has been done, on Chandrakala Devi Dhananjaya and her book *Shishubodha Tarangini* is not sufficient, it is incomplete. On the context of patriarchal country Nepal, research on the woman contributors in Nepalese mathematics would play a dominant role for uprising the women in the field of study and research in mathematics. Therefore, I am interested to conduct research on biography and mathematical contribution of Chandrakala Devi Dhananjaya in Nepal.

Implications of the Review for the Study

Historical research describes what was. The process involves investigating, recording, analyzing and interpreting the events of the past for the purpose of

The researcher explored mathematical contribution of Chandrakala Devi Dhananjaya on the basis of triangulation within her biography, analysis of her book and analysis of contemporary mathematics books. This study mainly concentrated on mathematical contribution of Chandrakala Devi Dhananjaya and analysis of her contemporary Mathematics books. In order to explore her contribution in Nepalese Mathematics, the researcher went through the biography of Chandrakala Devi Dhananjaya. Therefore, at first the researcher studied about biography with the help of in-depth interview, documents analysis. In this section, the researcher studied different aspects of Chandrakala Devi Dhananjaya: childhood, family background, interest, difficulties and rewards. It is assumed that biography helped to analyze her book.

The researcher used content analysis approach to analyze her book named *Shishubodha Tarangini* where the researcher described prevailing conditions, importance, interest, problems, level of difficulty, use of symbol, literary style, arrangement and area of content. It is also believed that contemporary books such as *Wyakta Chandrika* of Gopal Pande, *Gorkha Bijganit Shichchha* of Pa.Nuru Datta pande would help to analyze. Furthermore, the researcher studied ancient Mathematics books like *Lilawati*, *Bij-Ganita* to find out what type of content included in the book that Chandrakala Devi Dhananjaya wrote.

Chapter-III

METHODS AND PROCEDURES

This chapter deals with the design of the study, area of the study, sampling procedure, information collection tools and procedure, and information analysis and interpretation procedure. Which has need fulfill the objectives of study. At each operational step in the research process, researchers are required to choose from a multiplicity of methods, procedures and models of research methodology, which would help them to best achieve their objectives. Methods means the way of collecting information for the chosen study and interview, observation, group discussion, documents analysis are the popular methods practiced in qualitative research (Sharma, 2011). The research questions were answered using qualitative data. The researcher was chose primary and secondary data as source of data. Most of the data collected from libraries, research reports, journals, study of the book, resource persons etc. the nature of study was historical bases.

Design of the Study

This research work would attempt to explore the biography and contribution of Chandrakala Devi Dhananjaya in Nepalese mathematics. The researcher cannot manipulate any events and neither control environments so the design of this study is qualitative and historical descriptive. The researcher used content analysis approach in which researcher employed published works as its data (in the case of history of textbooks, these might be readers, or examples of the changing contents) and subjects them to a careful analysis that usually includes qualitative aspects. Document study such as books of Chandrakala Devi Dhananjaya and other related literature, interview was the methods to collect the information. The research questions were answered using qualitative data and it mostly based on in-depth interview and library study.

Area of the Study

The nature of this study was historical type based on document analysis. Area of this study is biographic and exploration of mathematical proof and explanation. The study was based on the book *Shishubodha Tarangini* of Chandrakala Devi Dhananjaya and her biography and contemporary mathematics of her period.

Sampling Procedure

The nature of this research was historical and qualitative basis. Sampling is the process by which a relatively small number of individuals, objects, or events are selected in order to find out something about the entire population. In this way it is very difficult to get the direct person to do the research on the contribution and biography of Chandrakala Devi. Researcher completed the research with inquiry to the related person of Chandrakala Devi and also with the research of her related books was helpful to complete this research. In this way it was used the method of snowball sampling method to start the research work. Where snowball sampling building up a sample through informants. In addition, the researcher analyzed the documents as the contents analysis in the mathematical pattern.

Tools of the study

There are many approaches for the qualitative and descriptive research to get the information. Thus the researcher was used primary data including in-depth interview and counseling with resource person. The secondary sources of information for the study was taken from the printed and collected documents like journals, books, documents, articles, and related literature.

Information Collection Procedures

First of all, the researcher visited different libraries, consult resource persons and teacher to collect necessary information for research. The researcher studied

classical documents like books, journals etc. to analyze mathematics book. The main source to this research was interview with resource persons for the biography of Chandrakala Devi Dhanjaya. The researcher went to the field to take in-depth interview for further inquiry with the nephew, grandson of Chandrakala Devi. To collect information the researcher used personal communications such as telephone calls, and SMS texts with respondents. Then researcher conducted documents analysis and evaluates the information in content basis of mathematics.

Information Analysis and Interpretation Procedure

The study is based on Historical documentation and description. Thus, the analysis of information required interpretation of them in a logical, analytical and descriptive manner. The researcher was collected data of information for the study from distinct sources. The researcher analyzed and interpretation this information analytically. The researcher divided this analysis and interpretation in to two parts. First part about Chandrakala's biography, which includes childhood, family background, adult, overview as mathematician, interest, difficulties and about her mathematical personality and the Second part was about analysis of *Shishubodha Tarangini* on the basis of mathematics content, languages, etc. with the help of books: *Wyokta Chandrika*, *Shishubodha Tarangini*. The researcher compared and constructed content of book with current secondary curriculum of Nepal because *Shishubodha Tarangini* seems to be prepared for 6-10 class.

Chapter- IV

ANALYSIS AND INTERPRETATION OF INFORMATION

Biography of Chandrakala Devi Dhananjaya

This chapter dealt with biography of Chandrakala Devi Dhananjaya. To get as detailed as possible biography of her, the researcher discovered her family background, childhood, interest and nature, habits, education and economic status, marriage and family life, visits, rewards and influence and motivation to write having an in-depth interview with her kiths and kin and acquaintances.

Family background

The researcher requested with Modnath Prasit, the nephew of Chandrakala Devi Dhananjaya to describe her family life in detail. He answered as followed;

"Mrs Chandrakala Devi Dhananjaya, the fourth daughter of the father Himlal Paudel and the mother Kunta Paudel was born in 1915AD, district Arghakhanchi, V.D.C. Mandre was a mathematician. During the very period of her birth the village was naturally beautiful and enchanting pleasurable. The village was very prosperous in education and culture however it was the time of Rana reign due to the residency of thick Brahamin family. Although Chandrakala could not take the formal education due to the conservative concept regarding not to provide the education to the women but the father belonged to the Brahamin family so the family was educated. They used to conduct ritual works along with they had agricultural occupation. Since the family was big, all were very diligent and used to work hard in the field."

In conclusion it can be said that although her family was big but they were very hard working so they did not have any problem to sustain the life. From the very beginning Chandrakala seemed to have grown intense interest in her child psychology about mathematics since the family was educated and her father used to conduct

different sorts of ritual activities like jotting down and foreseeing the fortune and horoscope of the people.

Childhood

In the history of Nepalese Mathematics the first woman teacher/mathematician Mrs Chandrakala born in 1915 A.D in V.D.C. Mandre of district Arghakhanchi was very genius. According to the information obtained from the grandson of Chandrakala, he quoted that,

"She was the fourth daughter among nine of the children of her parents. She had two brothers, three elder sisters and three little sisters. she was very inquisitive and flickering sorts of girl so that from the beginning of 4/5 years of age she used to go with her father in the village in ritual works. The children start to think consciously from the age of 6/7 years however she got married at the age of 7 years but she went to her husband's home at the age of 10 years that's why her childhood was more affected by the family of her husband rather than her own. At that time, she got married with the youngest son named Tikaram Dhananjaya of the father Pandit Ekadev Marasini and the mother Narayani Marasinini who belonged to V.D.C. Khidim of the same district. The educational background of Tikaram was quite good since the family was so civilized and the atmosphere of the family was also educated. Tikaram had got the education up to Madhdhyama (equivalent to I.A.). She had spent her childhood in such an atmosphere."

To sum up she was so inquisitive and spry girl as well as she had spent her days from her childhood in the home of her husband so it can be concluded that she was more affected by her husband's family environment. She might be inspired and encouraged to write books from such environment.

Interests

She was very inquisitive from the very beginning of her childhood in comparison of her other sisters and brothers that are the reason she used to go with her father in the ritual works in the village. The family environment immensely affects the interests and desires of the person so she was not an exception. Her own mother's home was also educated as well as sooner she had gone to her husband's home at her late childhood so the effect of her husband's home could be seen extensively. As per the enquiry of the researcher, the grandson said in this way;

"Her husband had already commenced to step ahead in the field of writing at the age of 11 and due to that family background is was not a strange to be interested in the field of writing as well as in other household works for her. She seemed to have the manner of querying and knowing. When Tikaram had gone to Banaras for his higher education, he used to send letter to his wife Chandrakala but He had taught her wife a very different language because the letter could be seen by others and sometimes they did not used to deliver to her. As a whole it can be said that she was interested in linguistics and learning."

Marriage and Family Life

According to Hindu culture it was the customary to get married at the early ages. It was the superstitious perspective of the people that they would go to the hell if anyone gave the hand of the daughter after menstruation that is reason that people used to marry even at the age of 10/11years. Because of all this Chandrakala Devi also got married in 1923 A.D at the age 7 years with the youngest son Tikaram Dhananjaya aged 14years of the father Pandit Ekadev Marasini and the mother Narayani Marasini the inhabitants of Khidim VDC of Arghakhanchi district. She had only gone to her husband's home at the age of 10 years although she was married

earlier at the innocent age. According to the information obtained from the grandson of Chandrakala, he quoted that,

"Grandpa Tikaram had got little black complexion, oval face, thin and tall boy and on the other hand grandmother Chandrakala had got fair complexion, round face and little fat and short in hight."

Now let's go through the introduction of Tikaram Dhananjaya the husband of Chandrakala Devi. According to the Nepalese Hindu culture the girl has to stay in the home of her husband and she is given the name, caste and even the home of the husband after marriage. The youngest son Tikaram of the father Pandit Ekadev Marasini and the mother Narayani Marasini was genius, savant, author, translator, linguist and researcher. He used to write *Gotra Dhananjaya* after his name instead of *Marasini* his real caste. He was born in 1909 A.D at the time of *kartik Shukla Dashami*. He had got five elder brothers and two elder sisters and he was the youngest one. Due to the educated and civilized family environment the family background was educated too. He grew up with the educated environment of Khidim area and his study was also fine. During that time, Pandit Dadhiram Marasini had been running the *Gurukul* education center at his own home in 1913 A.D when he returned to Khidim after accomplishing his education. After starting the *Gurukul* education from the center of his own uncle Pandit Dadhiram Marasini, Tikaram had studied *Chandi, Veda Kosh, Grammar and Kavya* at the age of adolescent. Tikaram passed *prathama pariksha* (equivalent to lower secondary level) after studying in Khidim till 1924 A.D. Then he went to Baranasi for his secondary level education and he passed *Madhyama parishya* (equivqlent to I.A.) in Sanskrita Grammar in 1927 A.D.

The family of Chandrakala was well civilized and educated and the father-in-law used to teach and conduct rituals work in the village as well as even her husband

used to teach in various schools of his village after returning back accomplishing the study. In this way, Chandrakala Devi was assisted in her writing and she was encouraged in writing by her husband. According to the information obtained from the grandson of Chandrakala Devi, he quoted

" Unfortunately her husband passed away untimely at the early age of 26 years so she could not get enough time to spend with her husband and approximately she had spent 10 years of tome with her husband. In this way after the demise of her husband, she started to confront difficult days. From the very late childhood almost at the age of 11years, she used to get encouraged by the writing, compiling and preparing poems, astrology books including mathematics of her husband but untimely demise of her husband had created lots of troubles in her practical life."

She had got a son named Madhav Marasini. Chandrakala was added with so many other responsibilities like rearing up the child, providing education to the son including so many other household responsibilities after the death of the responsible husband that hindered her to go for the other works. We might have got so many other works of her if she lived with her husband a bit longer.

In conclusion it can be said that she was immensely encouraged in writing since her husband's family background was civilized and educated and her husband also used to teach. Although she had spent her beginning days in happiness but unfortunately due to the untimely demise of her husband, she went through lots of difficulties that are the reason-limited numbers of her masterpieces are available.

Educational and Economic Condition

Chandrakala who was born in 1915 AD had not taken any formal education. It was less even for the male to take formal education and education for the girls was beyond the expectation. Although it was very much convenient for her in the field of

writing because of her educated and civilized family. As her nephew Modnath Prasit quoted that,

"She was illiterate until she went to her husband's home since she was only married at the early age of 7 years and she only moved to her husband's home at 10 years of age. Chandrakala got lots of inspiration and opportunities to learn about various things from the education of her husband. Although Tikaram was the Madhyama (equivalent to I.A) holder in the Sanskrit Grammar, his intense interest was in the self study of mathematics and astrology so he started to teach the very subjects in his own village khidim. This became the reason for Chandrakala that she also gained knowledge from her husband since the person is tremendously affected by his/her surrounding atmosphere. Chandrakala had also learnt the basic things till that time. Then she also started to write the books with the assistance of her husband and engaged in teaching profession. She published a book entitled as upadesh Chandrkala in 1934 A.D from the inspiration and the company of her husband. After reading her book, the contemporary king of Jajarkot was impressed and wrote a letter to Tikaram Dhananjaya and Chandrakala dhananjaya and requested to teach his son and daughter respectively."

She got lots of opportunities to learn about many things after her arrival at her husband's home from the family atmosphere. Since the Khidim V.D.C was even regarded as the educated area and even during the period of Rana reign the one who used to go to *Banarasi* for the higher study should come back to the village and used to teach in the schools. The father-in-law and her husband were also involved in the field of teaching. Her husband Tikaram had studied the *Chandi*, *Veda Kosh*, Grammar and *Kavya* in the *Gurukul* Education center of his own uncle's home Pandit Dadhiram Marasini who had been running the center after coming back to the village after

accomplishing higher education. Tikaram got lots of inspiration from his own uncle and started to compose the poems even at the age of 11. He returned to the village in 1929 A.D after completing his higher education and having lots of knowledge and experiences regarding various subject matter from *Banarasi*. He began to be involved in literary creation, writing the subjects like mathematics and astrology, *Tika lekhan*.

To sum up it can be clear that there is great significance of her husband Tikaram who had taught Chandrakala from recognizing the letter to write the books. In this way the writing of mathematics of Chandrakala began to move ahead.

Visit

During that period there was not such a tradition to go on a formal visit and only the emperor and kings used to go on a visit, on the other hand there was no facility of transportation. People would go on foot wherever they needed to go. Likewise, while investigating more about the author, Nephew of Chandrakala replied as follows;

"Although she did not have any experiences of formal visit, she had visited many places with her husband such as Pokharathok and she had gone to Bardiya when her husband was the teacher. She had travelled so many religious places with her husband like Banaras, Badridham of India. Her picture can be found that was taken when she had gone to Banaras with her husband, mother-in-law and her son Madhav".

Rewards

Regarding the rewards and prizes there was no such a provision of awards at that time. No importance was given to the person except *Rana* family. And there was not a system of evaluation of any tasks, on the other hand she was the woman that was beyond imagination to evaluate and award the females during that period.

Chandrakala seemed to bring the knowledge of mathematics into reality among the people instead of women empowerment and prestige. Even the male writers were found in very rare number, Chandrakala stepped ahead in the field of mathematics writing even after saving time from her household works should come to be the indispensable matter. Her every Endeavour should deserve to be evaluated.

Inspiration and Impression

Chandrakala Devi was born in 1915 AD and she was married with Tikaram Dhananjaya at the age of 7 years. She was very spry from the very childhood. She seemed to be very inquisitive and curious to know the things around. She got lots of opportunities to do other works besides her household works after her marriage when she went to her husband's home at the age of 10 years. Her family was civilized and educated as well as her husband had initiated writing poems at the age of 11 years. Then after she was also inspired in the field of writing with the help of her husband. She had written *upadesh Chandrakala* with the assistance of her husband. That book is comprised of stories written in standard *Sanskrit* language as well as she had written another book entitled as *Shishubodha Tarangini* during the very period.

That *Shishubodha Tarangini* was written in three parts; First, Second and Third respectively but only the second part is available. Her husband was regarded as the erudite person at that time. He had studied, taught and written so many books. He had prepared *Nepali Tika of Lilawati*. Astrologist Durga Praasad Gautam had informed Modanath Prasit that Chandrakala had created her book named *Shishubodha Tarangini* on the basis of *Lilawati*.(Prasit, 2002)

Masterpieces published by Chandarakala Devi (Prasit, 2002)

1. *Upadesh Chandrakala (Part I)*

Published date:-1934 A.D

Publisher: - Ba. Shivaprasad Radhoram, Gorkha Pushtakalaya, Ramaghat, Baranashi

2. *Shishubodha Tarangini(Part I &III) (Unavailable)*

3. *Shishubodha Tarangini(Part II)*

Published date:-1933 A.D

Publisher: - Ba. Shivaprasad Radhoram, Gorkha Pushtakalaya, Ramaghat, Baranashi

Printing: - Jyotish Prakash Press, Bishweshowergang Baranasi

Analysis and Interpretation of Shishubodha Tarangani

South Asia is one of the four early places where human evolution began as like to Egypt, China, and Iraq. 5 or 6 thousand years ago India gradually shattered into Asia and formed the Himalaya and Hinda Kush Mountains that almost block of India from the neighboring area. Historians also archaeologists believe the Harappan Civilization (Indus Valley Civilization) began around 3000 BCE in the Indus River. The Vedas were first written down in a language called Sanskrit. Sanskrit was a spoken language that was written down in diverse writing systems that developed later on such as Devanagari (the early form of Hindi, Nepali language) (<http://en.wikipedia>). Hinduism was an amalgamation/incorporation of beliefs and practices from several sources. The discovery of the Indus Valley Civilization in the nineteenth century revealed a sophisticated and long-forgotten ancient culture that appears to have contributed to the development of the Hindu traditions (Shrestha 2014).

Shrestha, (2014) in his book *Philosophy of Mathematics* mentions that although the almost 3000 years old Vedas are mostly devoted to describing Gods and Goddesses, it represents ancient civilization as well as shows the origin of mathematics in such areas such as economic policy, algebra, geometry, astronomy and so on. *Sulva Sutra* was developed in order to systematize geometrical knowledge that was developed from Hindu practices needed in making bedi and fire places (agni sthal) (Boyer, 1968)

Sulva Sutra was developed in order to systematize geometrical knowledge that was developed from Hindu practices needed in making Bedi and fire places (Agni sthal) (Boyer, 1968). Shrestha further writes that although the credit is given to the seventeenth century scientists Newton and Leibniz in developing calculus, it has been found that the development of fundamental ideas in calculus such as value of π (π), expansion of infinite terms of trigonometry was in existence before the second century in Kerala (India). This shows the contribution of Hindu civilization in mathematics. When talking about Hindu mathematics, Mahabir's Jainism has also played an important role in the sixth century. Similarly, great mathematician Aryabhata systematized the then mathematical practices and created *Aryabhattiya* in fifth century. Hindu civilization created great mathematical ideas and this has been evidenced with the creation of Brahamagupta's 'Bramha-sphuta-siddhanta' in eighth century, BhaskaracharyaII's *Lilavati* in the eleventh century, Ananda Guru in the thirteenth century, Punya in the fourteenth century, Ramanuj in the seventeenth century.

By following similar manner, Chandrakala Devi Dhananjaya had written various books among them *Shishubodha Tarangini* is based on mathematics and astronomy. However, she cited some content from *aryebattiya*, *lilavati* and *Wyakta*

Chandrika (Prasit 2002). Furthermore, *Shishubodha Tarangini* was chiefly based on the *Wyakta Chandrika* of Gopal Pande.

Modnath Prashit wrote "Chandrakala Devi Dhananjaya published this book *Shishubodha Tarangini* for teaching mathematics and Jyotish specially to children". The book named *Shishubodha Tarangini* is rarely found in the present time being practiced in a reformed manner. The book is no more in practice these days, however, the content of the book are still.

The researcher could not get original version of *Shishubodha Tarangini* therefore unable to claim about the size however, it contained 80 pages. There is also not a written preface, it is written *Ba. Shiva Prasad Radhoram, Gorkha library, Ramghat, Banaras* city as publisher and has published in "*Jyotish Prakash press, Biswashowarganj Banaras*.(Appendix-B)

In this book, we can see many mathematical problems related to unitary method, profit and loss square root and cub root, HCF LCM, Fractions, Decimal, simple interest, sequence etc. On the concern of other feature of the book, the researchers see that this book started with

श्रीगणेशायनमः । श्रीबराहाय कुलदेवतायै नमः । श्रीपतिचरणारविदाभ्यां नमः ।

The first verse of this book is an invocatory verse on Lord Ganesha, *Kul debata*, and other gods. It was customary in those days before the beginning of any auspicious event. We can see this type of customs practiced in *Lilavati*, most popular book of Hindu Mathematics written in eleventh century of BhaskaracharyaII and *Wyakta Chandrika*, renowned book of Nepal as well of India written by Gopal Padey that were practiced in ninth century.

Firstly, she defines the various units of money which were in vogue during those days.

चाँदी ८ लालको १ माषा १२ माषाको १ तोला हुन्छ ।
सून १० लालको १ माषा १० माषाको १ तोला हुन्छ ॥

The above verse indicates the different measurement system in the past like measures of gold. Here, although the weight is equal but it is said that silver is 1 *masa* equals to 8 *lal* and 1 *tola* equals to 12 *masa* and on the other hand gold is 1 *masa* equals to 10 *lal* and 1 *tola* equals to 10 *masa*. Likewise it is found that there is less silver in *lal* in comparison to gold and in *masa* less gold in comparison to silver.

Likewise, there are given so many other units of measurements like the units of length, measures of grain in volume and lastly the measure of time. This indicates that the text is quite formal in treatment. It sets the character of the work not as an abstract piece but rather one of practical significance in day-to-day applications moreover, she justifies use of mathematics in everyday life. It clearly states that the value of digits increase by a factor ten from right to left.

Contents of Shishubodha Tarangini

Shishubodha Tarangini mainly deals with what we call as 'Arithmetic' in today's mathematical parlance. It consists of 134 verses written in Nepali as well Sanskrit in poetic form (terse verses). There are certain verses which deal with number system, fundamental operation of mathematics, decimal and its operation, fraction and its operation, interest, HCF, LCM, annuity, Profit and loss, unitary Method, sequence and series etc. Moreover, it also includes certain elements of algebra such as finding an unknown quantity subject to certain constraints using the method of supposition.

व्यापारीले पचीशको दरगरि रिङ्गमा पाँचसौली दुशाला ।
एकसौ तेत्तीस् सताइस्दरगरि घरमा येचिहाले छ काला ॥
दोस्रो पचास् उनतिस् दरगरि हरिया बाँकि तेत्तीस दर्ले ।
सेता बेचेछ नाफा भन्निमि अहिले कति पायेछ तेस्ले ॥४॥

It means to say that a merchant bought 500 shawls costing Rs. 25 per shawl. Among them, he sold 133 shawls costing Rs. 27 per shawl, 250 shawls costing Rs. 29 per shawl and he sold the remaining 117 shawls costing 33 per shawl, how much profit did he get after selling all the shawls?

In summary content of *Shishubodha Tarangini* may written as

-) Fundamental operation of mathematics
-) HCF and LCM
-) Fraction and Decimal
-) Square and Square root, Cube and Cube root
-) Unitary method
-) Sequence and Series

Fundamental Operation of Mathematics

Chandrakala Devi has presented the subject matter of her book from simple to complex, problems are design to explore and developed creative and critical thinking, problems are based on the surrounding and tried to connect mathematics to real life context. To justify it broadly firstly she has generally introduced number counting, addition and subtraction, multiplication and division as well as she has given the problems having brackets. Like this

+ यो सङ्कलनको चिह्न हो, यसलाई धन चिह्न भन्दछन् ।

= यो बराबर चिह्न हो ।

— यो व्यकलन चिह्न हो, यसलाई ऋणचिह्न भन्दछन् ।

× यो गुणनको चिह्न हो ।

÷ यो भागहारको चिह्न हो ।

— () { } [] ई कोष्ठक हुन् यस्मा पहिला-चिह्नलाई दीर्घमात्रा भन्दछन् । ई आम्का भिन्न संख्या हरूको एकरव देखाउँछन् । जस्तै=(७ + ४)-(५-२) वा { ७ + ४ } — { ५-२ } वा ७ + ४-५-२ अथवा [७ + ४]-[५-२]=८ इ सबैको बराबर ८ हुन्छ अर्थात् ७ + ४ को योग ११ मा ५-२ को अंतर ३ घटाउनु भन्ने ई चिह्नले नुमाये ।

She has justified the algorithm of addition after the function of brackets and after that; she has clarified the process with the instances. She has not only applied this process in addition but also in subtraction, multiplication and division that makes the students or the readers easier to gain the mathematical knowledge. However, she has included the significant process like simple to complex, chaining process in her book that made the development of the eastern mathematics powerful independently like the western mathematics.

HCF and LCM

Her book includes the topics related to HCF and LCM after addition, subtraction, multiplication and division and the same process has existed even in this era. It means to say that the book *Shishubodh Taranginin's* syllabus has been considered to arrange its scope and sequence as well as it includes the psychological aspects very well since the arrangement of the syllabus based on its scope and sequence is time relativistic in modern time too. Let us discuss what sorts of problems are presented about HCF and LCM:

Chandrakala, under the topic of HCF and LCM, has defined as follows:

१-महत्तमापवर्तन मनेको । दुइ वा अधिक राशिलाइ जुन संख्याले भाग दीदा निशेष हुन्छ तेसलाइ अपवर्तन भन्दछन् । ती अपवर्तन हरमा जो सबै भन्दा ठूलोछ तेसलाइ ती राशिको महत्तमा पवर्तन भन्दछन् ।

If two or more than two variables are divided by a number without remaining is called refraction and the highest number among that refraction is called HCF.

१- जो दुइ अथवा अधिक राशिले जति राशिलाइ निःशेष गर्दछन् उती राशीमा जुन सबै भन्दा सानू छ उमै लाइ नौ दुइ अथवा अधिक राशीको लघुतमापवर्तन भन्द छन् ।
जस्तै=४, ५, ६ ले ६० लाइ र १२० । १८० लाइ निःशेष गर्दछ, इ सबै मध्ये ६० सानू छ तसर्थ ४ । ५ । ६ को लघुतमापवर्तन ६० भयो ।

If two or more than two variables divide any other variables without remaining, the smallest number among those variables is called LCM.

After the definition, she has literally presented the methods of computing HCF and LCM in poetic form. Since there are various ways to compute HCF and LCM included in her book. She has presented the computation of HCF and LCM as follows:

चौध चौतीस फे बीह्र छत्तीस इनको पनि ॥
महत्तमापवर्तन् सव् धनस्त्रीकति भो गनी ॥ २ ॥

१४ र ३६ को ल्याउंदा १४) ३६(२

$$\begin{array}{r} 2 \times \\ \hline 28 \\ \hline 6) 36(2 \\ \hline 12 \\ \hline 2) 12(3 \\ \hline 6 \\ \hline \end{array}$$

नाले २ महत्तमा पवर्तन् भयो ।
 अस्तै = १२ र ३६ को ल्याउंदा १२ ले निःशेष हुने हुनाले १२ नै महत्त-
 मापवर्तन् भयो ।

It means that:

14 and 34 again 12 and 36 too

What is the HCF of that after counting?

Ans. HCF of 14 and 34

$$\begin{array}{r} 14 \cancel{A} 34 \cancel{f} 2 \\ \hline 28 \\ \hline 6 \cancel{A} 4 \cancel{f} 2 \\ \hline 12 \\ \hline 2 \cancel{A} 6 \cancel{f} 3 \\ \hline 6 \\ \hline | \end{array}$$

Here divided by 2 without remaining so 2 is the HCF

In the same way to calculate the HCF of 12 and 36, 12 is the HCF.

Fraction and Decimal

After HCF and LCM Chandrakala has included fraction and decimal with their operations like addition, subtraction, multiplication and division in her masterpiece. In the book, *Wyaktachandrika* of Pd.Gopal Pande defined fraction as; when a quantity is composed of one or more equal parts of the unit, its measure is called a fractional number and simply fraction (Pande, 1883). One of the examples is given like this:

तिन्त्रे चारले नानि ! चार्ले तीनले गुण ।
 दोचले तीनले फेरी चार्ले दो गुणी भन ॥ १ ॥
 जस्तै = $\frac{3}{4} \times \frac{4}{3} = \frac{12}{12} = 1$ भयो । $\frac{2}{3} \times \frac{3}{2} = \frac{6}{6} = 1$ भयो ।

It means to say that $\frac{3}{4} \mid \frac{4}{3} \times \frac{12}{12} \mid 12 \times \frac{1}{1}$ and $\frac{2}{3} \mid \frac{4}{2} \times \frac{8}{2} \mid 2 \times \frac{4}{3}$

Next problem:

उदाहरण ।
 सात, फेतिन् बिन्दुचौबिस्, फेर बिन्दु पचत्तर ।
 बिन्दुशून्य यकावन्न ई सक्को नानि ! योग्गर ॥ १ ॥

The above verse means to say, what is the sum of 7, 3.24, 0.75 and 0.051?

The verses are also quite poetic and beautiful. The use of poetic language typically involves the use of such adjectives as, O! Auspicious girl, Oh Friend! Oh Brother! My beloved, Nani etc. This clever use of language is partly teasing but also engaging and challenging the students intellectually. This is quite contrasting to modern mathematical text books, which are always in prose form and quite dry.

Square, Square Root and Cube, Cube Root

The first mathematics book written in Nepali language by Gopal Pande named *Wyakta Chandrika* involves the arrangement of the contents and since it was widely used and it was popular in the schools at contemporary age so it is seen some influence in her book too. General introduction and the methods of calculating square,

square root, cube, cube root is mentioned in *Shishubodha Tarangini* like *Wyakta Chandrika*. Among them one is presented below.

बाह केरि दुइसौ सतानवे ।
 दशहजार तिन, फेरि वानवे ॥
 हुञ्ज वरग इनि अङ्कको कति ।
 जान्दछौ भनि बताउ भट्भटि ॥ ७ ॥
 जस्तै = १२ को वर्ग १२ \times १२ = १४४ । २९७ \times २९७ = ८८२०१ ।
 यस्तै १०००३ \times १०००३ = १०००६०००९ । ९२ \times ९२ = ८४६४ इ वर्ग भये ।

The above given verse indicates: What is the square of 12, 297, 10003 and 92?

As similar to square and square root, Chandrakala presented problems related to cube and cube root in her book.

घननौको भन अनी तिनका घनको घन ॥
 जानेकाछौ घनभने पाँचका घनको भन ॥ १३ ॥
 जस्तै = ६ को घन ६ \times ६ \times ६ = २१६ तीनका घन २७ को घन १९६८३ । भयो १२५ को घन १९२३१२० भये ॥

Unitary Method

Generally, unitary method means technique of carrying out a calculation to find the value of a number of items by first finding the cost of one of them. It sets the tone of the work not as an abstract piece but rather one of practical significance in day-to-day applications. Among the so many mathematics books of eastern Hindu Philosophy, some are *Aryabhattachiya* of fifth century, *Brahmasiddhanta* of seventh century, *Lilawati* of Bhaskaracharya of eleventh century. Among these aforementioned books Bhaskaracharya has talked about unitary method through *Lilawati*. Unitary method is equally given the significant place in the modern time as it was given in the ancient time (Kandel, 2015). *Shishubodha Tarangini* is no more an exception. One of the examples is given as:

रामेले आठदिन्मा गरदछ उहिकां सोमरेले छदिन्मा ॥
तेहीद्वै जनाले सँग मिलि गरदा हुन्छ काम कति दिन्मा ॥

Ram can do a piece of work in 8 days; so can Som in 6 days.

In what time will they do it if they work together?

Although she has not included about the separate chapter of simple interest and compound interest in her book *Shishubodha Tarangini*, She seemed to have adequate knowledge about simple and compound interest. She has clearly presented the problems and solving methods of those problems regarding the interest. One of the instances is presented as follows:

कोही एकजनाले दियेछ रूपीजा आठ् सैकडा वर्षका ।
दले तीनसये पचास, तिसवै लीयेर ये रीतका ॥
चक्रैद्वि वियाजमा तिन वरस्सम्मन् तिनीकी कती ।
हुँदो भो भन सुदली तिमि यहाँ जान्ने भये भदभरी ॥२॥
उत्तर २० ॥२३॥

The above verse says: - What is the compound interest of the principal 350 with 8% interest rate in 3 years?

To study the book *Shishubodha Tarangini* with deep inspection it is found that there is not used the formula of calculating profit and loss as mentioned in present mathematical text book of secondary level. Furthermore, in her book, the content like profit and loss, use of percentage, concept of cost price are not mentioned but her book includes the practical problems of profit and loss. The mathematical books that were published during the contemporary period in Nepal primarily focused on solving the practical problems instead of developing mathematical knowledge, which is also mentioned by Kandel, 2015, Acharya, 2008.

Sequence and Series

The concept of sequence and series are found to be mentioned in her book. During the early thirties of the twentieth century, the books that were taught in Nepal in Nepali language like *Wyakta handrika*, *Bichitra Ganit*, *Ganit Sagar*, *Saral Ganit*, *Gorkha Bijganit Kshikhya*, *arithmetic*, *Patiganit* also do not include the concepts like sequence and series. However, the book *Shishubodha Tarangini* is found to be one step ahead in comparison with the books aforementioned regarding the matter of sequence and series. She has presented the method of calculating sum of natural number having the 'n' terms in a poetic form verbally.

She presented different formulas to compute sum of arithmetic series and those formulas are arranged simple to complex manner. Firstly, she wrote the rules of addition as:

**एकजोडेर पदले पदार्धकन गूणन् ॥
ओ अङ्कको योग यही सङ्कलित् भनि जानन् ॥१॥**

Here, we cannot see any mathematical symbols and any numbers however, it gives very appropriate formula to compute the sum of first 'n' natural number of a series. It means:

Add one in the numbers of term and multiply by half of number of terms and it is the sum of that series.

Mathematically it means:

If $1+2+3+4+\dots+n$ is a series of first 'n' natural number.

Therefore, here total number of terms = n

Add one to the number of terms 'n', so it becomes (n+1) and need to multiply this term (n+1) with half of total term i.e. n/2.

According to the above sum of this series $(n+1) \cdot \frac{n}{2} = \frac{n(n+1)}{2}$ which is sum of first 'n'

natural number

Most common formula to compute the sum of natural number is also even exactly appropriate nowadays. Moreover, she posed an example of series where such formula can be used that means she wrote as follows:

**एकवज्रदा एकहान्यो दुइ दुइ वज्रदा एहिरित्ते गराइ ।
हान्यो भन् बाहवज्रदा कतिपटक यहाँ योगङ्को बनाई ॥**

The above verse says: It struck once when it was 1 o'clock, it did twice when was 2 o'clock. In this way how many times did it strike when it was 12 o'clock?

In addition to this, She computed above problem in this way:

Here, number of term=12

By adding 1 in this, we get $12+1=13$ and need to multiply half of number of term i.e. $12 \div 2 = 6$ so we get $13 \times 6 = 78$ or $1+2+3+4+5+6+7+8+9+10+11+12=78$ which is the sum of above problem.

Chandrakala has not only presented the formula of calculating the sum of first 'n' natural number but also presented the formula of calculating the sum of the sequence that is made of the sum of first 'n' natural number.

To clarify it in other way:

If sum of first one natural number = 1

Sum of first two natural number = 3

Sum of first three natural number = 6

..... = 10

..... = 15

..... = 21

..... = 28

..... = 36

..... = 45

..... = 55

.....=66

Sum of first 12th natural number = 78

To compute such series, she wrote:

**सङ्कलित्साह पदमा दुइजोडि गुणी अनी ।
सङ्कलित्को योग हुन्छ तिनले भाग दियो भनी॥२॥**

There is not seen any mathematical symbol but verbally she expressed mathematically

Sum of first n(12) natural number $\frac{n(n+1)}{2} \times 78$ by adding 2 in total number of terms

i.e. (n+2)=12+2=14. and multiply with first n(12) natural number i.e. $78 \mid \frac{fn \Gamma 2A}{3}$

$$=78 \mid \frac{14}{3}=364$$

The result of such computed will be the sum of series if this is divided by 3 i.e.

$\frac{n(n+1)(n+2)}{2 \mid 3}$. It is a sum of addition. To compute such series, she wrote:

**एक् घटाह पदमा अयलाई ।
गुणि आदिधन जोडि रमाई ॥
अन्त्यधन हुनगयो यसलाई ।
आदि जोडिकन आधिगराइ ॥३॥**

Firstly in this above verse she introduce basic formula to calculate sum of arithmetic

series when first term, last term, common difference, number of term are known as

last term (l) = nth term = $t_n = fn \Gamma 1A \Gamma a$ and adding first term a and divide by 2 i.e.

$$S_n = \frac{n}{2} \bullet 2a \Gamma fn \Gamma 1A \Gamma a' \text{ or } S_n = \frac{n}{2} \bullet \Gamma a'$$

She presented a example to clarify this formula:

पैन्हा दिन्मा चारुमीजा दियेर ।
 दीयो दिन् दिन् पाँच रुपीजाथ फेर ॥
 बाहुन लाइ तेसले पन्ध्र दिन्मा ॥
 कची देला जान तीमी रुपीजा ॥ २ ॥

It means; A person gives four rupees in a first day to his priest the than he increased five rupees per days. Calculate how much money did he gives up to fifteen days?

Moreover, she solves this problem as follows;

Here, first term =4

Common difference =5

Number of term =15

Here, $74 + 4 = 78$ this is last term (l)

Again, $74 + 4 = 78 = \frac{78}{2} \times 15$ this is midterm .Now $39 \times 15 = 585$

also using above formula

$$S_n = \frac{n}{2} (a + a_n) = \frac{15}{2} (74 + 78) = \frac{15}{2} \times 152 = 1140$$

Most common formula to compute the sum of natural number which is almost same as now a days. Moreover, in current textbook of secondary mathematics of Nepal as well other SAARC countries we can see such mathematical problems related to sequence and series as similar manner of Chandrakala's *Shishubodha Tarangini*, this provided that mathematical knowledge is discovered not invented because how it is possible to remains same before 100 years and now a days .

In this way it is clear that she presented the formula of arithmetic series in poetic version in a very marvelous way which proves that she was not only expert in mathematical knowledge but she seemed to be rich in creating the literature.

The book is written in a very simple way. It includes the subject matter presented in it from simple to complex way. Arithmetic and Algebra related subject

matters are included in this book. Before solving any problems, the rules for solution are given in the chapter and after that, the problems are solved respectively. Another good aspect of the book is that the same problem is solved by applying various methods. This book includes both general and specific questions. This means it is not easy to answer for which level of students the book is prepared. This is also not clear for which grade the book is for.

The book has great significance in the present time because it provided the basis as well as reference for the present day's teachers to devise mathematical books. The books had been undertaken in order to supply a demand for an easy introduction to elementary mathematical concepts for Nepalese students. At that time in Nepal, few mathematics books in Nepali languages had been published on Mathematics and desired to prepare new treatise on Mathematics which contained the mathematical problems almost in verbal forms. Despite being the old book, it had got the content of present time textbook. . Nepali words have been used for questions in examples and practice. For variables, we can see Nepali sounds and alphabets. This shows that the Nepali-speaking students can benefit from the book. In the book, there are Nepali units of measurement (*Dam, Paisa, Lal, Masa, Mana, Pathi, Aana, Ropani, Mann, Auns Angul, Bitta* etc) and practical problems, which shows the formation of original questions by the author.

The book had followed the scientific way of presenting the each question from easy to difficult, concrete to abstract. It had been seen that this book tried to develop and kept latest pedagogical principals on mathematics. All sorts of questions are gathered together in a same place where as the book is strong in providing answers too to facilitate the students. Chandrakala had used her own verity of symbols of words of typical Nepali languages. The questions had been given in arbitrary forms so

it is useful. To quote the weakness, all sorts of questions are gathered together in a same place where as the book is strong in providing questions and their solving too to facilitate the students.

She used verbal problems in slokas form, which were based on mathematical formulas. She used an advanced learning theory induction like to find the sum of natural numbers. Therefore, she has better knowledge of teaching and learning theory. Thus, she has advanced pedagogical concept for learning and expressing such concept through her book *Shishubodha Tarangini*.

Chapter V

SUMMARY, FINDINGS, CONCLUSION AND IMPLICATIONS

This chapter encapsulated all the major finding in precise form on the basis of analysis and interpretation of the data. It also deals with implications, which are made on the basis of summary and conclusions discovered form the study.

Summary

The first book of mathematics written in Nepali language is found to be *Wyakta chandrika* and it was published in 1883 A.D. This book was based on the *Lilawati* of Bhaskaraacharya. The mathematician and teacher pd. Gopal Pande wrote this book. This book contains numerous problems dealing with favorite topics of hindu mathematics; linear and quadratic equation, geometric, progression, surds, Pythagorean triads, both determinates and indeterminate simple menstruation, arithmetic and geometric progressions and others. Other famous and scalars and writers in mathematics were Nuru Datta Pande, Master Merunath Pande, Kabiraj Pande , Ganga Prasad Shrestha. During that time one Nepali lady Chadrakala Devi Dhananjaya has written *Shishubhodha Tarangini* in slokas form which was published in 1933 A.D. She has been supposed to be the first Nepali lady writer of mathematics book and teacher in Nepal who had a sound knowledge of mathematics at that time. No Nepali lady mathematician has been seen before and after her as a single writer of mathematics book.

In the history of Nepalese Mathematics the first woman mathematician, writer and teacher Chandrakala was born in 1915 A.D. She was born as the fourth daughter of her father Himlal Paudel and mother Kunta Devi Paudel of Arghakhachi district. She got married at the age of 7 years with Tikaram Dhananjaya the youngest son of father P. Ekadev Marasini and mother Narayani Marasini resident of the same district

Arghakhachi. Her own family environment as well as the family environment of her husband influenced her since she had gone to her husband's home at her early age. Her husband has commenced writing poems at the age of 11 years. After the accomplishment of his study, he had started to teach in his own village and had initiated to write various books. Her husband encouraged her from recognizing the letters to book writing. She became successful in writing the book entitled as *Shishubodha Tarangini* by utilizing the family environment and the cooperation as well as the company of her husband.

Findings

Through the study of biography of Chandrakala Devi Dhananjaya, her contemporary and analysis of *Shishubodha Tarangini* the following results are the major finding of the study:

-) She got inspiration in writing from her own family although she got married at her early age. Her husband was the writer who had started writing poems at the age of 11 years. He was *Madhyama* (I.A.) holder from *Sanskrit* in qualification however his major interest was in Mathematics and astrology. In this way she could write the book by the assistance and company of her husband.
-) Although Chandrakala did not taken any formal education, her husband had taught and assisted her from recognizing the letters to book writing as well as she was encouraged to write the book by the help of her family. It was found that Chandrakala used the local terms in measurement like *Mana, Pathi, Aana, Ropani, Auns, Paisa, Gadda, Tola, Angul, Bitta* etc. are used which has also provided evidence the use of ethno-mathematical concepts.

-) Inspiration and encouragement can be found to learn mathematics in the book of Chandrakala Devi Dhananjaya.
-) Pedagogical expression like simple to complex as well as examples to problem solving procedure can be found.
-) Inductive method to be found in her book *Shishubodha Tarangini*.
-) In 1933s, practical mathematics was practised which was mainly based on daily activity.
-) It was found that the book provides a solid base for the growth of individual learning. Moreover, it contains the mathematical problems which are still in modern curriculum of six to ten class of Nepal.
-) She expressed her mathematical problems-answer in poetic form.

Conclusion

In conclusion, the focus of the study has to highlight the contributions of Chandrakala Devi Dhananjaya in Nepalese mathematics through her book named *Shishubodha Tarangini*. Chandrakala who was born in 1915A.D had not taken any formal education. It was less even for the male to take formal education and education for the girls was beyond the expectation. Although it was very much convenient for her in the field of writing because of her educated and civilized family. Chandrakala got lots of inspiration and opportunities to learn about various things from the education of her husband. Her husband Tikaram Dhanjaya had studied the *Chandi*, *Veda Kosh*, Grammar and *Kavya* in the *Gurukul* Education center of his own uncle's home Pandit Dadhiram Marasini who had been running the center after coming back to the village after accomplishing higher education. Tikaram got lots of inspiration from his own uncle and started to compose the poems even at the age of 11years Although Tikaram was the Madhyama (equivalent to I.A) holder in the *Sanskrit*

Grammar, his intense interest was in the self-study of mathematics and astrology so he started to teach the very subjects in his own village khidim. This became the reason for Chandrakala that she also gained knowledge from her husband since the person is tremendously affected by his/her surrounding atmosphere. Her husband besides teaching, used to translate the famous epics and other various books of *Sanskrita*, write mathematics and books concerning astrology and he used to teach other subjects and prepare the horoscopes of the people. Chandrakala had also learnt the basic things till that time. Then she also started to write the books with the assistance of her husband and engaged in teaching profession.

The book *Shishubodha Tarangini* is no more in practice these days, however, the content of the book are still being practised in a reformed manner. The researcher could not get original version of *Shishubodha Tarangini* therefore unable to claim about the size however, it contained 80 pages. The letters inside the books were visible, large enough to see, understandable, compressive and written in Nepalese languages with few *Sanskrita* languages as well. Some vocabulary are not today's fashion however, these can be understood. It started with remembrance of god *Ganesh*, and *Home* god as it was customary in those days and till now before the beginning of any auspicious events. Moreover, *Shishubodhani Tarangini* mainly deals with what we call as 'Arithmetic' in today's mathematical fashion. It consists of 134 verses written in Nepali in poetic form (terse verses). There are certain verses which deal with algorithm for adding, subtraction, multiplication, division, LCM and HCF, square root and cub root, Fraction (adding, subtraction, multiplication, and division), Decimal system, Rule of three, simple interest, unitary method and sequence and series.

To sum up, *Shishubodha Tarangini* includes the questions that are clear although they are in *Sanskrit* term as well as it contains the words like *Nani, Babu, Oh!* etc. This book focuses on arithmetic along with menstruation, simultaneous equations in addition to, we cannot see a problem of geometry. This book is practised as the text book because it contains so many examples that lead to various questions and eventually the solution to those questions. Furthermore, it contains the problems to modern curriculum of classes from six to ten. Although there is no declaration that for which propose text book had been written and if it was prepared for academic purpose we could get acknowledged for that level.

By means of publishing the book, she had played the great role in the development of mathematics. On the basis of the study, interview and analysis Chandrakala Devi's contribution in Nepalese Mathematics through her book could be drawn as follows:

-) It was presented simple to complex form.
-) It bridged the gap between ancient and modern mathematics.
-) It was a practical mathematics since it was based on daily activities.
-) It supplied the lack of mathematics book in Nepali language.
-) It provided the basis and reference to write mathematics book nowadays.
-) It enhanced a culture of writing mathematics book in Nepalese language.
-) Her book based on teaching-learning theory like inductive method, problem solving method.

Last but not the least, her book had been proved as a milestone in the scenario of Nepalese mathematics.

Implications

This is a biographical and content analysis related study. According to the findings and conclusions of the study, some implications of this study are pinpointed.

The following are the implications of this study:

-) Biography of Chandrakala Devi Dhananjaya and her contribution in Nepalese mathematics could be helpful to study further Nepalese mathematicians and their contributions in different aspects.
-) Biography of Chandrakala Devi Dhananjaya and her contribution in Nepalese mathematics could be paramount to recognize Nepal in the international context of mathematics.
-) Through the findings and conclusions of this study, other researchers could be curious to search and documenting the mathematical creations of other Nepalese people
-) The findings and conclusions of this study could urge other researchers to conduct the research work on the Nepalese history of mathematics and its usefulness in nation's development.
-) By knowing the importance of classical mathematics, government and policy makers should formulate different policies for the preservation and development of classical mathematics

References

- Acharya, E. R. (2011). *An Analytical Study of Nepalese History of Mathematics*. Research Center, T. U.: Unpublished.
- Acharya, E. R. (2009). *Gorkha Bijaganita Shiksha ko Samikksha*. Mathematics Education Forum, 8-15.
- Acharya, E. R. (2012). *Prof. Naya Raj Pant As an Institution of Mathematics*. Journal of Ramanujan Society of Mathematics and mathematical Science , 23-28.
- Acharya, E. R. (2015). *Study on Mathematical treatises of Nay Raj Pant*. Unpublished, Phd desertation, Nepal Sanskrit university, Dang.
- Acharya, E., & Pant, S. (2068). *Chandrakala Devi Dhananjaya in Mathematical History & Shisubodha Tarangini*. Sungabha Pratibimbha, 23-31.
- Banerji, H. C. (1927). *Lilavati* (Colebrooks Translation). Calcutta: Girinra Nath Mitter of Messrs.
- Barj, M. (1965). *History of Matheamtics*. Lakhnau: Hindi Committee, Information Department.
- Best and Kahn. (1995). *Research in education*. new delhi: prentice-Hall.
- Bhattari, L.N., Adhikari, K.P., Neupane, A. (20130). *The History of Mathematics*. Kritipur, Kathmandu: Quest Publication
- Bogden, R. (1992). *Qualitative research for education*. Bostan: Allyn & Bacon.
- Boyer, C. B. (1968). *A History of Mathematics*. New York: John Wiley & Sons. Inc.
- Calise, A. S. (2057). *Nay Raj Pants' Biography, Persanality and Kritito*. Kathmandu: Shree Khilraj Sharma Rajib Lochan Joshi Smarak Pratisthan .
- Chakavarti, J. C. (1920). *Arithmetic*. Bejoy Kumar matira of Messrs, Sanyal and Co.
- Cooke, R. (2005). *The History of Mathematics*. New York: Wiley-Interscience.

- Datta, B., & Singh, A. N. (1938). *History of Hindu Mathematics*. Allahabad: The Allahabad Low Journal Press.
- Dhananjaya, C.D (1933). *Shishubodha Tarangini (part II)*. Ramghat, Baranashi: Ba. Shivaprasad Radhoram, Gorkha Pustakalaya.
- Gottschalk, L. (1951). *Understanding History*. New York : Alfred A. Knopf. 1951. New York: Alfred A. Knopf.
- Hada, R., Amagain, D. N., & Rana, L. B. (2012). *Mathematics Book Eight*. Kathmandu: Cambridge Publication Pvt. Ltd.
- Kandel, K.P(2015). *Biography of Bramha Lal Shrestha and his contribution on Nepalese mathematics*. Unpublished, thesis, T .U Kirtipur.
- Khanal, S. (2069). *Contribution of Nay Raj Pant in Siddanta Jyotische*. Kathmandu: Khilshrma Ragib Lochan Joshi Smarak Pratisthan.
- McNeill, W. H. (2014, July 17). *Why Study History?* Retrieved from American Historical Association: <http://www.historians.org/about-aha-and-membership/aha-history-and-archives/brief-history-of-the-aha>
- Niure D.P.(2069). *Research Methodology*.Kritipur, Kathmandu: Quset Publication
- Olsen, L. W. (2002). *Essays on Georg Rasch and his contributions to statistics*. University of Copenhagen, Institute Of Economics. Copenhagen: Unpublished.
- Pade, G. (1883). *Wyokta Chandrika*. Mumbai: Nirnaya Sagar Press.
- Pandit, E. R. (2011). *History of Mthematics Education in Nepal*. Mathematics Education Forum , 19-23.
- Pant, N. R. (1980). *Pd. Gopal Pandey and his method of getting Cube Root*. Kathmandu: Royal Nepal Academy.
- Pant, S. R. (2008). *Astrologer Laureate Pandit Laxmi Pati Pade*. Newsletter , 13-15.

- Pant, S. R. (2004). *Mathematics in Nepal; a Analytical Analysis*. Scientific world , 30-35.
- Pant, S. R., Jha, K., & Adhikary, P. R. (2006, July 16). *A History of Mathematical Science in Nepal*. Retrieved from KU Web site:
http://www.ku.edu.np/kuset/second_issue/e2/KANAIYA%20JHa-pdf.pdf
- Prasit M. (2059). *Bahumukhi Pratibha Tikaram Dhananjaya*. Anamnagar, Kathmandu: Unnayan Prakashan.
- Sharma, L. N. (2011). *Qualitative Research*. Bagbazar, Kathmandu: paluwa Prakashan.
- Sharma, L. N., Awasthi, R. P., Subedi, B. B., Timalsena, T., Chaudhary, K. C., Dhadkn, D. K., et al. (2067). *SLC Coppetitors' Comp.Mathematics*. Bagbazar: Bhudipuram Prakashan.
- Shrestha, B. L. (1918). *Vichitra Ganita*. Kathmandu: Pasupati Press.
- Shrestha, G. P. (1916). *Ganita Sagar*. Kathmandu: Pasupati Press.
- Shrestha, M. B. (2013). *Philosophy of Mathematics*. Kamaladi, Kathmandu: Nepal Pragma Pratisthan.
- Upadhaya, H. P., Pradhan, J. B., & Dhakal, B. P. (2067). *Trends in Mathematics Education*. Kathmandu: Balbalika Education Publication.
- Wikipedia. (2014, 07 16). Retrieved from History of Nepalese Education:
http://en.wikipedia.org/wiki/Education_in_Nepal

Appendix A

Chandrakala Devi Dhananjaya and Her Contribution in Mathematics

Sample Interview Questions for Her Family Member

- I. Describe her family life in detail.
- II. Please explain early childhood of Chandrakala Devi Dhananjaya.
- III. Briefly recount birth, birth of her siblings.
- IV. Mention her Marriage.
- V. Her husband's death and its impact on her further life
- VI. Do you have any idea who supports her writing in mathematics?
- VII. What were her desires and wishes?
- VIII. How many places did she visit?
- IX. Please mention her educational status.

Appendix B

Some pages of *Shishubodha Tarangini*

॥ श्रीः ॥

श्रीचन्द्रकला देवि धनञ्जय विरचिता—

शिशुबोधतरङ्गिणी ।

द्वितीयभागः ।



प्रकाशकः—

बा. शिवप्रसाद राघोराम

गोर्खापुस्तकालय

रामघाट-बनारस सिटी ।



पाइने ठेगाना—

सर्व हितैषी कंपनी

रामघाट-बनारस सिटी ।

* शिशुबोधतरङ्गियां *

तौलमा ।

चाँदी ८ लालको १ माषा १२ माषाको १ तोला हुन्छ ।

सून १० लालको १ माषा १० माषाको १ तोला हुन्छ ॥

जिनसी मालमा यहाका बाकजो १ पैसालाइ १ तोला भन्दछन् १८ तोलाको १ पाउ, ४ पाउको १ सेर, ६ पाउको एक विसौली, २ विसौलीको १ धानी ।

खेतका विषयमा ।

राजाजयस्थितिमहका २४ अङ्गुलको १ हात तेसलाइ चिनकडी भन्दछन् ५॥॥) पौने ६ हातको १ टाँगा हुन्छ ।

लमाबिटाँगा ४
अवल खेतमा
गज टाँगा ४

को एक मुरी.

लमाबिटाँगा ४
दोयं खेतमा
गज टाँगा ४

को एक मुरी.

लमात्री टाँगा ५
सोयं खेत
गजटाँगा ४

को एक मुरी,

लमाबि टाँगा ६
चहारं खेतमा
गज टाँगा ४

को एक मुरी.

एकमुरीलाइ एक जवापनि भन्दछन् ।

४ जवाको १ रोपनी, २५ रोपनीको १ खेत, हुन्छ ।

नेपालका तराहीमा ६ हातको १ लगा हुन्छ । एकलगा चौडार एकही जगा लामा खेतलाइ १ धूर भन्दछन् । २० धूरको १ कट्टा, २० कट्टाको १ विघा, हुन्छ ।

नापमा ।

पेटमिलाये का ८ जौको १ अङ्गुल, १२ अङ्गुलको १ वित्ता, २ वित्ताको १ हात, ४ हातको १ दण्ड, २००० दण्डको १ कोश, २ कोशको १ योजन हुन्छ ।

समयमा ।

एक गुरुअक्षरका उच्चारणकाललाइ १ विपला भन्दछन् ६० विपलाको १ पला, ६० पलाको १ घडी, ६० घडीको १ दिन, ३० दिनको १ महीना, १२ महीनाको १ वर्ष हुन्छ ।

* गणिततरङ्गः *

गणितका चिह्न ।

- + यो सङ्कलनको चिह्नहो, यस्ताइ धन चिह्न भन्दछन् ।
- = यो बराबर चिह्नहो ।
- यो व्यकलन चिह्नहो, यस्ताइ ऋणचिह्न भन्दछन् ।
- × यो गुणनको चिह्न हो ।
- ÷ यो भागहारको चिह्न हो ।

— () { } [] ई कोष्ठक हुन् यश्मा पहिला-चिह्नजाइ दीर्घमात्रा भन्दछन् । ई आम्मा भिन्न संख्या हरूको एकत्र देखाउछन् ।
जस्तै—(७+४)−(५−२) वा {७+४}−{५−२} वा ७+४−५−२
अथवा [७+४]−[५−२]=८ इ सबैको बराबर ८ हुन्छ अर्थात् ७+४ को योग ११ मा ५−२ को अंतर ३ घटाउनु भन्ने ई चिह्नले बुझाये ।

वर्ग धन चतुर्बल पञ्चबल इत्यादि का क्रमैने चिह्न $\frac{2}{2}$ $\frac{3}{3}$ $\frac{4}{4}$ $\frac{5}{5}$ हुन् । इनका मूलका चिह्न पनि क्रमैले $\sqrt{\quad}$ $\sqrt[3]{\quad}$ $\sqrt[4]{\quad}$ $\sqrt[5]{\quad}$ हुने हुन् ।

- > यो समच्छेद चिह्न हो ।
- :- यो अपवर्तन चिह्न हो ।
- ∝ यो उल्ट्याउने चिह्न हो ।
- ∴ : : यो त्रैशिक को चिह्न हो ।
- ∵ यो जस कारण को चिह्न हो ।
- ∴ यो यस कारण को चिह्न हो ।

यहाँ देखि अगाडी पट्टि सब चिह्नले लेखियेका छन् विचार साथ बुझनु ।
इतिपरिभाषा ।

॥ अथाभिन्न परिकर्माष्टकम् ॥

योगको उदाहरण ।

तिन्हज्जार चवालिशैतक कलीयुग्मा युधिष्ठिरजिको ।
संवत् चल्दधियो अनीपत्त्रि चण्यो विक्रं महाराज को ॥
एकशौ पैतिशवर्षसम्प अनिफेर् श्रीशालिवाहनजिको ।
अष्टारैसय ह्यपनै वितिगयो जम्मा कतीवर्षभो ॥ १ ॥

जस्तै = ३०४४ + १३५ + १८५६ ई जोड़दा जोड़ि सके पत्त्रि बराबर चिह्न = का पत्त्रि लेखनु, जस्तै ३०४४ + १३५ + १८५६ = ५०३५ ॥ इति सङ्कलनम् ।

* गणिततरङ्गः *

अर्को उदाहरण ।

चौध चौतीस फे बाह छत्तीस इनको पनि ॥

महत्तमापवर्तन् सब् भनलौकति भो गनी ॥ २ ॥

१४ र ३४ को ल्याउंदा १४) ३४(२

२८

६)१४(२

१२

२)६(३

६

× यहाँ २ ले निःशेष गरे कोई

नाले २ महत्तमा पवर्तनभयो ।

यस्तै = १२ र ३६ को ल्याउंदा १२ ले निःशेष हुने हुनाले १२ नै महत्त-
मापवर्तन भयो ।

प्रश्न

एकैवाजि परिक्रमा संग संगै गर्छौं भनी सूर्यको ।

एऊटो दुइसौ चऊतिस घुम्यो चासौं बतिस् आरको ॥

गर्दा ताँहि परिक्रमा तिदुइको हूँ दो भयो भेट्कती ।

गर्छस् शेखि गणीतमा यदि भने उत्तर्वता भट्भटि ॥ ३ ॥

(३) जुन राशिका रुमरधानि अंकको योग र विपमस्थानी अंक हरू का योगको अंतर ०
शून्य अथवा ११ले निशेष हुन्छ भने त्यो राशि पनि ११ ले निःशेष हुन्छ ।

जस्तै = ७४५८ यस्मा ७ × ५ = १२। ८ × ४ = १२ इ दुइको अन्तर ० हुन्छ । अनि ८३६
यसमा ८ × ६ = १७। ६ इ दुइको अंतर ११ले निशेष हुने हुनाले ११ यसको अपवर्तन भयो ।

सबै राशिको पृथक् पृथक् खण्ड गर्नु फेरी जति संख्या सबैका खण्ड मा छन् तीनको
घात गर्नु महत्तमापवर्तन हुन्छ ।

जस्तै २८८, ४३२, ३०० को महत्तमा पवर्तन ल्याउंदा,

२८८ = १६ × १८ = २ × २ × २ × २ × २ × ३ × ३.

४३२ = २४ × १८ = २ × २ × २ × २ × ३ × ३ × ३.

३०० = २५ × १२ = २ × २ × ३ × ५ × ५. अतः महत्तमा पवर्तन २ × २ × ३ = १२.

* शिशुबोधतरङ्गियां *

उदाहरण

जाँदा दश रेल भाड़ा दिई शहर गई शेष दो बर्बनाइ ।
दश खायो फर्कदामा दश तिर घरमा तेहि मानीस आइ ॥
यैरिल्ले तिन शहरमा घुमि घर पुगदा तीन दोब्बररेख ।
पैलो धन्लाइ, तेस्को भन तिमि पहिलो धन् कती ? लौ रहेख ॥४॥

जस्तै = यस प्रश्नमा ४५ रुपैया इष्ट मानेर गर्दा = १० रेलभाड़ा दियेको हुनाले घटाउँदा ४५-१०=३५ भयो । यो शहरमा गई दोब्बर बनाये को हुनाले २ ले गुणदा ३५×२=७० भयो । यसैमा १० खायो १० फर्कदा रेलभाड़ा तिरको हुनाले ७०-१०=६०। ६०-१०=५० रह्यो, यस्तै दोआ शहर वाट घर फर्कदा ६० तेश्रा वाट फर्कदा ८० भयो ।

फेरि ४५ लाइ ३ ले गुणदा ४५×३=१३५ भयो यस्मा ८० घटाउँदा १३५-८०=५५ शेष रह्यो ।

फेरी अर्को इष्ट ५० कल्पना गरेर गर्दा ५०-१०=४०। ४०×२=८०अनि ८०-१०=७० । ७०-१०=६० पहीला शहर वाट फर्कदा भयो यस्तै दोआ वाट फर्कदा ८० तेश्रा वाट फर्कदा १२० भयो ।

फेरी ५० लाइ ३ ले गुणदा १५० यस्मा १२० घटाउँदा ३० शेष भयो ॥

अब $\frac{५५ \times ५० - ३० \times ४५}{५५ - ३०} = ५६$ पहीजो धन भयो ।

उदाहरण ।

मैनाको शैकड़ा पाँचु दरगारि रुपिया व्याजमा कयै लगायो ।
तेही धन्वर्षदिन्मा द्विगुणित मुलमा सोह मै कति आयो ।
कन्ती तेस्ले रुपिया भन तिमि अट्टिले व्याजमाहाँ लगायो ।
जस्ले त्यो वर्षदिन्मा द्विगुणित मुलमा सोह कन्ती गरायो ॥५॥

जस्तै-यस प्रश्नमा २० इष्ट कल्पना गरि व्याज ल्याउँदा १२ आयो यस्मा २० जोड़दा ३२ भयो । फेरि २० लाइ २ ले गुणदा २०×२=४० भयो र ४० मा १६ घटाउँदा ४०-१६=२४ भयो यो ३२ मा घटाउँदा ३२-२४=८ शेष भयो ।

यस्तै = ३० इष्ट कल्पना गरि व्याजल्याउँदा १८ यस्मा ३० जोड़दा ४८ भयो । फेरि ३० लाइ २ ले गुणदा ६० यस्मा घटाउँदा ४४ भयो । यो ४८ मा घटाउँदा ४ शेष रह्यो ।

अब $\frac{८ \times ३० - ४ \times २०}{८ - ४} = ४०$ रुपिया व्याजमा लगायेख ॥

इति श्री शिशुबोधतरङ्गियां इष्टकर्मप्रकरणम् ॥

शिशुबोधतरङ्गिण्यां

जस्तै = मिसायका धन ५०।६६।८५ लाइ सर्वधन ३०० ले गुणदा
१५०००।२०७००।२५५०० भयो । अब मिश्र (मिसायको) धनको योग
 $५० + ६६ + ८५ = २०१$ भागलीदा $७३ \frac{२६}{९}$ । $१०१ \frac{६}{९}$ । १२५ ई क्रमैले
खण्ड भयो इनको योग ३०० हुन्छ ॥

अर्कामिश्रको रीती

अंशले हरमाभाग दीयेर अनि योगगरी ।
भागदेऊ एकमहाँ फलहुन्छ सरासरी ॥ ३ ॥

उदाहरण ।

दिनका तेसराभागमा छैटाभागमा बुभयी अनी ॥
आधादिन्मा दिन्भरीमा भिन्दै भर्खन् भने इनी ॥३॥
धारा त्यो पोखरीमाहाँ छोडे एकैवखत्पहाँ ॥
भरीयेला कतीकान्मा भन भट्ट तिमी यहाँ ॥४॥

जस्तै $\frac{३}{५} \frac{१}{२} \frac{१}{३}$ यहाँ अंशले हरमा भागदीदा $\frac{३}{५} \frac{१}{२} \frac{१}{३}$ भयो इनको
योग $\frac{१२}{३०}$ भयो यस्ले १ मा भागदीदा $\frac{१}{३} \div \frac{१२}{३०} = \frac{३०}{३६} = \frac{५}{६}$ भयो ।
अर्थात् दिनका १२ भागका एक भागमा भरीने भयो ॥

अभिन्नाङ्कका रीती ।

भनेका अङ्कको घात्मा तिनैका योगले अनी ॥
भागदेऊ फलभयो अभिन्नाङ्कमहाँ पनि ॥ ४ ॥

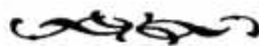
उदाहरण ।

रामेले आठदिन्मा गरदछ उहिकां सोमरेले छदिन्मा ॥
तेहीदूर्वे जनाले सँग मिलि गरदा हुञ्छ काम् कत्ति दिन्मा ॥
दो भैसी पाँच दिन्मा सकछन जुन घास् गाइ तिनसात दिन्मा ॥
एकूगाई एक भैसी मिलिकन सकनन् सोहि घाँस्कत्ति दिन्मा ॥५॥

जस्तै = पहीला मा $\frac{६}{६} \times ८ = ४८ = ३ \frac{३}{७}$ दिनमा ॥

यस्तै = अर्कामा $\frac{२ \times ५ \times ३ \times ७ \times १ \times १}{२ + ५ + ३ + ७ + १ + १} = \frac{२१०}{१६} = १३ \frac{१}{१६}$ दिनमा ॥

इति श्रीशिशुबोधतरङ्गिण्यां मिश्रव्यवहार प्रकरणम् ।



* गणिततरङ्गः *

❀ अथ श्रेढीव्यवहारः (१) ❀

सङ्कलितको रीती ।

एकजोड़ेर पदले पदार्धकन गूणन् ॥

भो अङ्कको योग यही सङ्कलित् भनि जानन् ॥१॥

उदाहरण ।

एकजोडा एकहान्यो दुइ दुइ वजदा एहिरित्ले गराइ ।

हान्यो भन बाइवजदा कतिपटक यहाँ योगङ्को बनाई ॥

जस्तै = यहाँ पद १२ छ यसमा १ जोडा १२ + १ = १३ भयो । यसले पद १२ को आधा १२ ÷ २ = ६ लाइ गुणादा ६ × १३ = ७८ भयो ॥

अथवा १ + २ + ३ + ४ + ५ + ६ + ७ + ८ + ९ + १० + ११ + १२ = ७८ हुन्छ ॥

सङ्कलित्कायोगको रीती

सङ्कलित्लाई पदमा दुइजोडि गुणी अनी ।

सङ्कलित्को योग हुन्छ तिनले भाग् दियो भनी ॥२॥

उदाहरण

एक दिनमा एकदीयो तिन दुइ दिनमा तीन दिनमा छ फेरी ।

यैरित्ले बाइ दिनमा भन कति दियहो सङ्कलित् योग हेरी ॥१॥

जस्तै = १२ को सङ्कलित् ७८ लाइ पद १२ मा दुइ जोड़ेर १२ + २ = १४ ले गुणादा ७८ × १४ = १०९२ भयो यस्लाई ३ ले भागदीदा १०९२ ÷ ३ = ३६४ भयो अर्थात् १२ दिनमा ३६४ रुपैया दिये छ ।

यथोत्तर चयमा अन्त्य मध्यादि धनल्याउन्या रीती-

एक घटाइ पदमा चयलाई ।

गूणि आदिधन जोड़ रमाई ॥

अन्त्यधन हुनगयो यसलाई ।

आदि जोडिकन आधि गराइ ॥३॥

(१) मंगल जोडि १, २, ३, ४ इत्यादि क्रमसँग अङ्कका कामलाई श्रेढीव्यवहार भन्दछन् ।

(२) कति सम्म अङ्क भन्दछ तसलार पद भन्दछन् । जस्तै = ६ सम्मका अङ्कको योग गर यस पदमा २ पद भयो । यहाँ ६ मा १ जोड़ेर ६ + १ = ७ ले ६ को आधा ६ लाइ गुणादा ६ × ७ = ४२ भयो यस्मा पत्ती एक देखि क्रमसँग नौमम्म अङ्क जोडा पनि गेयो हुन्छ जस्तै- १ + २ + ३ + ४ + ५ + ६ + ७ + ८ + ९ = ४५ ॥

३- अथवा १-१-३-१-६-१-१०-१-१५-१-२१-१-२८-१-३६-१-४५-१-५५-१-६६-१-७८ = ३६४ पसलार जोडादा पत्ती उत्ती ३६४ भयो ॥