Chapter I

INTRODUCTION

Background of the Study

Human life is intimately connected to mathematics. Due to its importance in everyday life, mathematics is regarded as the foundation of all civilization. Therefore, mathematics is a subject in need and its significance is growing daily. Additionally, it is the most useful subject in every field, including social science, engineering, technology, and invention.

The growth of mathematics depends mostly on numbers and systems. One of the most crucial mathematical ideas is the number system and counting system, which are present in every civilization. The basic building blocks of mathematics are numbers. Logical analysis was used to construct algebra and arithmetic on the basis of numbers. It is possible to suggest that number is a synonym for mathematics because of the various human activities that depend on numbers to make sense. The ability to recognize the quantity of a single or group of objects is what is meant by the number. One to one correlation with object was the most often used method of counting among ancient people. In the ancient period the people used the fingers of hand and scratch in the bone of animalsto counting the numbers (Ifrah, 2044).Numerals and counting's are the part of everyday life. So, numbers and numeral systems are the supports of society. From the different civilization and communitiesof the world Numbersand numerals were developed. So, they need exchange and made common systems to each other(Acharya,2017). Operation of number and their function have occupied important in mathematics. There are many system was developed in the world. The famous usable number in the world are Devanagari,Hindu-Arabic number, Roman number etc. These numbersystem was developed in the different places in the worlds such as Babylon, China, Indus, and Egypt.

The first mathematics originated around five thousand years ago along the Egyptian civilization,Indus civilization, Chinese civilization (Merzbach&Boyer ,1968).Primitive people had well practices and struggle to developed the modern number system .They used different strategies to count the objects .The concept of number and counting developed so long before time ofthe recorded history and it is imagined that primitive. Ancient people use the method simply method of counting by employing the on single per sheep, goat etc. Letter counting by maintained by making collection of pebbles, sticks or making scratches in the

wall or on the stone. After 3000 B.C people used line to count their objects and mention in the sets.These evidence we found in the animals bone (Ebrahim,2010 cited in Yadav&Acharya,2017).

In the process of the development of the society it was realized to make extensive counts and then gradually the counting had to be systematized. This was done by arranging their numbers into convenient words, symbols, narrations and groups .perhaps in the early stages the vocal or spoken counting was widely used .In addition of vocal numbers finger sign used together as well (Boyer,1976 cited in Yadav & Acharya,2017).

In the context of Nepal first mathematician of Nepal is known as Gopal Pandey .He wrote his book *"Waktachandrika"*in his book he specially mention the rule of finding square root and cube root. Other mathematicians of Nepal are Naya raj Pant, Dharmapti bardhan, Balabhadra Joshi, Chakrapani Aryal, Laxmipati Pandey, Shrivansa Ramanajun etc. The above mathematician are famous mathematician of Nepal and there are different numeral system like Brahmi Numeral, Ranjana Numeral and Licchivi Numeral are nepali numbering script .We can find ancient mathematical evidence in zhong cairo cave of mustang scratch of Ashok Stambha , scratch of stone inPatan Durbar square etc. places(Yadav and Acharya,2017).

Therefore, the number is the sense and symbol script of mathematics. The basis of mathematics is numbers and the number system. It is essential to the growth of mathematical understanding. Nepali mathematicians are working to integrate global and ethno mathematics considering that numbers are used and present everywhere. Nepal is a country with many different languages, cultures, and ethnic groups. It is a place rich in rituals and culture. Every ethnic group in Nepal speaks a distinctive language, has a unique religion, and has its own distinct culture. They have their own numbering, counting, and number symbology systems. For instance, during the Licchivi era, people utilized the Licchivi numeral to represent numbers. In the Newari society, numbers and other symbols were denoted using the ranjana script or ranjana numbering script. Numbers play an advanced role in ethno mathematics and due to the fact that even the least educated people used numbers in their own systems.So, in order to learn more about the Nepali number system, which was formed in Nepal, I would like to conduct this research based on the development of the number system in Nepal.

Statement of the Problem

This study focuses mostly on Nepal's developing number system. Numeral systems including the Hindu-Arabic, Devanagari, and Roman systems were created during the ancient period. These number systems were created by several civilizations of the world. The notation of numbers found in village of Ishango on the shore of Lake Edward in Zaire. These are many column in Ishango bone where one column consists of four series of notches containing 11, 21, 19 and 9 notches. The monetary system in use through the Mesopotamia the Egyptian divide weeks into 10 days but years into 12 months, day and night into 24 hour. The basis of sexadecimal system simultaneous use of tens and twelves (Cooke, 1942).

To developed the number system ;at first developed the counting sense and later people practice the counting sense in the society and they symbolized themselves by own symbol such as Hieroglyphic number is base 10 number system ;where 1 is denoted by *staff* **,**and 10 is denoted by *hell ofbone*and 100 is denoted by *coli of rope*etc.(Subedi,2017). Like as Babylonian number system is in base 60. The Babylonian number are found in clay tablets and cuneiform script (Cook,1942). So,Sexadecimal system, Kharosti, Brahmi script, Licchavi script, Ranjana script,Licchivi script etc. script was developed in while symbolized and systematized numbers.

History is our way of living today. Today's age is the most advanced in terms of science and technology. Many new discoveries are made in the field of mathematics. Mathematical knowledge is linked with IT, and everyone is running with ICT-related mathematics, however the basic foundation of today's new creation is our historical knowledge. Today's new mathematical knowledge is built on the foundation of historical knowledge.

Some of the script also emerged in Nepal during many civilizations, and we may find many ancient mathematics evidence in various locations throughout Nepal. So, in the Nepali context, what are the numeral system were developed? What role did Nepalese mathematicians play in the development of the number system? To find out the answers to these questions, I choose the topic "**Development of Number System in Nepal."**

I tried to find out the answers to the following questions which were formed based on the research objectives. It contains study guidelines, methodology determination, research information, analysis, and reporting. The research questions are mostly utilized to convert accurate information about the research. The research question were as follows:

- Which numeral systems are literally developed in the context of Nepal and Nepalese society?
- What are the practices of the number system developed in Nepal?
- How local people use to count the things in everyday life? And there are different -different number system were used in different -different society and culture?
- What are the contributions given by Nepalesemathematicians to develop the number system in Nepal?

Objectives of the Study

There are different types of the number system used in the present time and these number system was developed in different civilization(Subedi,2017). Also some of the system like as Brahmi numerals,Licchavi numerals, Ranjana numerals was found in Nepal. In the context of Nepal; to find out the numeral systems specially developed in Nepali civilization and contribution of Nepalese mathematicians in the development of numeral system, I determine the following objectives :

- To explore the numeral system developed in context of Nepaland Nepali society.
- To analyze the contribution of Nepalesemathematicians in the development of numeral system.

Justification of the Study

History is one of our most significant property because it guides us in every step of our life. It is because of old history that we are in our current condition. Only through researching and publishing old history would we be able to preserve the fact of origin. There are numerous evidences that can be found in the development of the number system in mathematics. By searching that type of history of the number system we can find out the reason of developing number system and where we can found these evidences? Who were developed the system? Etc.

The research design was based on document analysis. The study focuses on the Nepalese numeral system and the contributions of Nepalese mathematicians to the development of the Nepalese number system. In sum up, this study had the following significance:

- The study depicts the ancient counting system and search the Nepalese number system &symbol of number system.
- It is helpful to find out the fact of contribution of Nepalese mathematicians in the development of number system in Nepal.
- It is helpful to the teacher and students to know the history of mathematics in Nepal and also how to perceive the counting system and number system in Nepal and how to symbolize the number.
- The study might be supportive document for those who are interested about the development of number system in Nepal and who still working in this field.
- The study provides an idea about document analysis approach. Etc.

Limitation of the Study

The study is conducted on the topic "Development of Number System in Nepal". In the context of Nepal, this study only related to the Nepalesenumber system such as; Licchavi number system, Ranjana numeral script and Brahmi numeral script only. And it only introduce the contribution of Nepalese mathematicians in the development of number system in Nepal.

Delimitation of the Study

This study related with the topic "**Development of Number System in Nepal"** the area of research is very wider but the researcher is only curious to find out the number system which are developed in Nepalese context and contribution of Nepalese mathematicians in the development of number system. The primary and secondary information are main source of this study. The historical document analysis is the main method of the study and it is based on qualitative research design.

So the researcher cannot manipulate any event and neither controls the environment. So, the design of the study is bounded on qualitative research and historical descriptive. Researcher collects the documents (journal, article, thesis etc.), visit the websites and administrative interview and collecting with resource person. Researcher conducts the inductive and triangulation methods for analysis and interpretation the data .so, the tools of this research are delaminated on in depth-interview with resource person and document analysis.

Operational Definition of Related Terms

Key terms refer to those specific terms used in the thesis. The operational definitions of key terms visualize their specific meaning consisting on the thesis. Some of the terms which are used in this study are defined as follows:

Number System. Number system is the counting sense of numbers. It pointed counting system of Licchivi numeral system,Ranjana numeral system and Brahmi numeral system.

Numerals. It is the symbolic and representative form of number system. In this study numerals represent the Licchivi,Ranjana,Brahmi numeral system.

Brahmi Numeral system. It is a numeral system which is the direct graphic ancestors of modern Indian and Hindu-Arabic numerals.Brahmi numerals were not used as positional system with zero. Rather it separates numeral for each of the tens (10, 20, 30) etc. In this study the Brahmi numeral system represent that numeral system which is developed in the ancient Nepal.

Licchivi Numeral System.t is also a numeral system which is developed at the period of Licchivi.The language of licchivi inscriptions was Vajjika and the particular script used in closely related to official Gupta scripts suggesting that the kingdoms to the south were a significance cultural influence. In this study Licchivi Numeral system denote the number system which is developed in Licchivi period.

Ranjana Numeral System. Ranjana is a scripts of writing language of Newar cast. It is used for printing Hindu and Buddhist scriptures and literature in Sanskrit and Buddhist hybridSanskrit used by the Newarcommunity. In this study Ranjana numeral is the system of numbers which is used in Ranjana scripts and it is developed from the country of Nepal.

Manuscript. It is hand written text recorded on the paper,palm,bitch leaf,stone,cloths,clay tablets etc. Here, manuscripts represent the recorded documents from Lichhivi,Ranjana,Brahmi manuscripts.

Civilization. The process of becoming civilized is called civilization. In this study civilization denotes the developmental stages of human life from where the number system is developed.

Contributions. Contributions means the giving of something that plays a significant part in making something happen. In this study contribution denote the contributions of Nepalese mathematician who contribute to develop numeral systems in Nepal.

Classical. Classical means the system considered of first significance in earlier times. In this study the term classical denote the evidences of Licchivi numeral system,Ranjana numeral system and Brahmi numeral system found in documents and many historical places.

Evidences. Evidence means that something that furnishes proof. In this study evidences means the symbolization of the three numeral system as;Lichhivi numeral,Brahmi numeral and Ranjana numeral system.

Chapter-II

REVIEW OF RELATED LITERATURE

To conduct an effective research, researcher is required to be familiar with related research, reports, articles, educational policies and program that helpin conceptualizing the problems,conducting and interpreting the findings (Khanal, 2019). The main objective of literature review is to gain familiarity with the subjects matter to get enough knowledge to develop conceptual framework. To gain the validity of the concept and to adopt appropriate research method. Literature works have been studies to analyze the information related to this study. The review also helps researcher to come up with a theoretical framework to guide the study.

Empirical Review

Several types of literature were received in this study which helps to make the concept clear for study and also to analyze and interpret the data. Some related literature was received as follows:-

Shahi (2015)carried out the research entitled “development of number system” with objectives to explore about the numbers perception on ancient people and to analysis the historical development of HinduArabic and Devnagari number system. He raised the research questions as; how did primitive people perceive the number? And how were the developmental phase of HinduArabic and Devnagari number system?Dealingthese questions, he concluded that the number perception is developed by logical thought on the object. The concept of number and numeral is comes from ancient human culture and human civilization. So the number is invention form different human civilization but not from the mathematicians. The modern counting is developing from one to one corresponding counting techniques. Numeral is developed by different graphical sign from ancient people and the ancient Brahmi script is the fundamental script of Devnagari number. The decimal place value Devnagari number system is developing around 5^{th} -7^{th}century a.d. the word devnagari is formulated by two words deva and nagari around 10^{th}-12^{th} century. Indian devnagari number transgression in Arab and Europe around 13^{th}-16^{th} century. It modified in to modern HinduArabic number. Sharada script also develop from Sanskrit and nagari script found around 7^{th} century so Devnagari is the fundamental basis of sharada script.

Acharya (2017)carried out the journal “Ranjana Numeral System: a Brief Information”. In this study, he try to find out the Ranjana numeral system in Nepal on the

Ranjana script. He found from this study Ranjana numeral system origin is in Nepal with Nepali bhasa.The Ranjana numeral system was developed in 199 BC in the Nepali numeral system.The Ranjana scripts was used mainly for decoration of Buddhistsworks. It contains ten numerals with the symbol of zero (o).It is parallel product of Brahmi and Licchivi numeral systemespecially in Nepal. Further he writes Ranjana numeral system occupied the lap of the largest script Ranjana in language script that focus it'simportant.

Maskey (2017) carried out a study "mathematics in Nepal". He presents the study in the workshop about the "Developmental Mathematics in Nepal". In his study he writes about the civilization of mathematics. He mention that the study of civilization of the world reveals that the indigenous mathematics is one of the elements of civilization. Also he mention that the civilization of the world gives the development of mathematical knwledge. The cultural heritage, costume and social values gives the own types of mathematical/numerical smolization.He told in his study the ancient mathematics developed from the vedic period of cultural heritage of south Asian people. From the different civilization of the world element of indegenious matheatics consisting of numerals, maesuring units for different objects and geometric shapes is its outcomes. He also mention that from the Bagmati civilization the numerals of Lichivi period(300-1200) to denote the numbers noticed from the inscriptions.Also the Ranjana scripts is submitted for he membership of U.N. in 1955 by Government of Nepal. Devnagari scripts are used in the kingdom of kantipur during the regime of king Pratap Malla (1641-1674)by the influence of Mugal empire.

He also presented the framework of human civilizationIn such as; The civilization of Kathamndu valley which is also known as Bagmati civilization,the civilization of Surkhet valley is near to Kakre Bihar is to be excavated, the civilization of himalaya region such as mustang valley etc. He conclude that the development of mathematics is the cultural heritage of mankind.The modern world has the impact of ancient civilization .He also mention the influenceof lilawati in Nepalese mathematics history .Contribution of Nepalese mathematician such as:Dharmapati Bardhan, Balabhadra Joshi, Chakrapani Aryal, Laxmipati Panday, Naya Raj Panta etc in the development of mathematics. The books *Vyaktachandrika,Ganita ,GorkhaVijaganitaSiksha*were published and also*Aksharanka Siksha* containg the knowledge of integrated subject matter including the number facts by Jaya Prithivi Bahadur Singh ,which is published in 1901.He also introduce the works of mathematical society of Nepal, mathematical research works done in Nepal etc.

Acharya (2018) carried out ajournal entitled "Evidences of Hierarchy of Brahmi Numeral System". The aim of his paper is to explore the hierarchy and the existence of symbol of Brahmi numerals on the basis of document analysis and symbol found at different manuscripts and monuments. In his journal he writes the Brahmi numeral are written from the left to right. Thepillar of Ashoka(300 B.C) was the most reliable source of Brahmi numeral. In Brahmi numeral system there is symbol of numbers 1 to 9 and 10,20,30,90,100,200 etc. In Brahmi numerals there is no positional notation and no notation for zero. Also, he mention that the Licchivi numeral system is also related to Brahmi numeral system. Where the Licchivi numeral system is well organized set of decimal based numeral system.

In Ashoka pillar there were found a word *'Atha Bhagiya'* this words means division by eight .In sum up he concludes that the Brahmi numeral system is indigenous mathematical development of South Asian subcontinent which is appeared in third century B.C.E. The evidences of Brahmi numerals are found in different places of Nepal and India like as: Ashoka Pillar of Lumbini, Niglihawa of Nepal and Bihar, Madhya Pardesh, Uttar Pardesh and Delhi of India etc.

Acharya (2015) has done research on the topic “Naya Raj Pantka Ganitya Kritiharuko Adhyayan.” In this research, Acharya explored the details biography and contributions of Nepali mathematicians late Prof. Naya Raj Pant. The research shows that late Prof. Naya Raj Pant was the great mathematician has well contribution on number system. Acharya found that; late Pant experimentally test about the cube root number, study about different number script and says Brahmi is the base of all Nepali number, work on different number system and more other. This literature provides evidence about different number system in Nepal and gives well idea in this research.

Subedi (2017) has done research on the topic “The development of numeral system in ancient Nepal” with objective; to expiation and origin of numeral system, to identify the structural of numeral system of Nepal, to explore the stage of development of numeral system and identify the invention or diffusion of Nepalese numerals. She followed the material collection and analysis methods in this research. She reviewed the different civilization of numeral history of world. At last, she has got the major finding as; before 10th century, all number system has base-10, no sign for zero, all system are ciphered, Nepalese numeral system does not replaced by another system over the period, Hieratic, Greek, Brahmi and Nepalese system are similar structure, numeral-sign for 9 is identical in Hieratic, Brahmi and

Nepalese, Egypt, China and Nepalese are identical base. This provides the much evidence for research concern on number system.

Acharya (2017) has an article "Licchivi Numeral System in Nepal".In his article Acharya explored the supportive facts of declaration of the number of symbols used in Licchivi numertaion system and its base system. He used the document analysis and historical base method to conduct his study. In his study Acharya found that the Licchivi period is the "Golden Period" in the history of Nepal. The Gupta characters were used in Nepali inscriptions. In his study he concluded that that the Licchivi numerals were used in 3rd century BC. andpracticed up to 10th century AD.It consists 18 numeric symbols. It is based in ten non-positionalsystem. It has numeric symbol to left to right and it has no zero symbols but the concept of zero is developed. It follow the theory of one to one correspondence counting principles with additive grouping system and pianos axioms for succession of numbers.

Theoretical Review

Any theory or principle provides the methodology, idea and guideline to the research and make study strong and valid. Number is important part of social phenomena .Number is so much applicable things in human daily life. In the history of the human civilization the number is developed consisting the base two, five, ten, twenty etc. For the counting and creation of number. Today we follow this system as the principle of number creation. Thus, I would like to review the following principle of base law.

Principle of Base Law

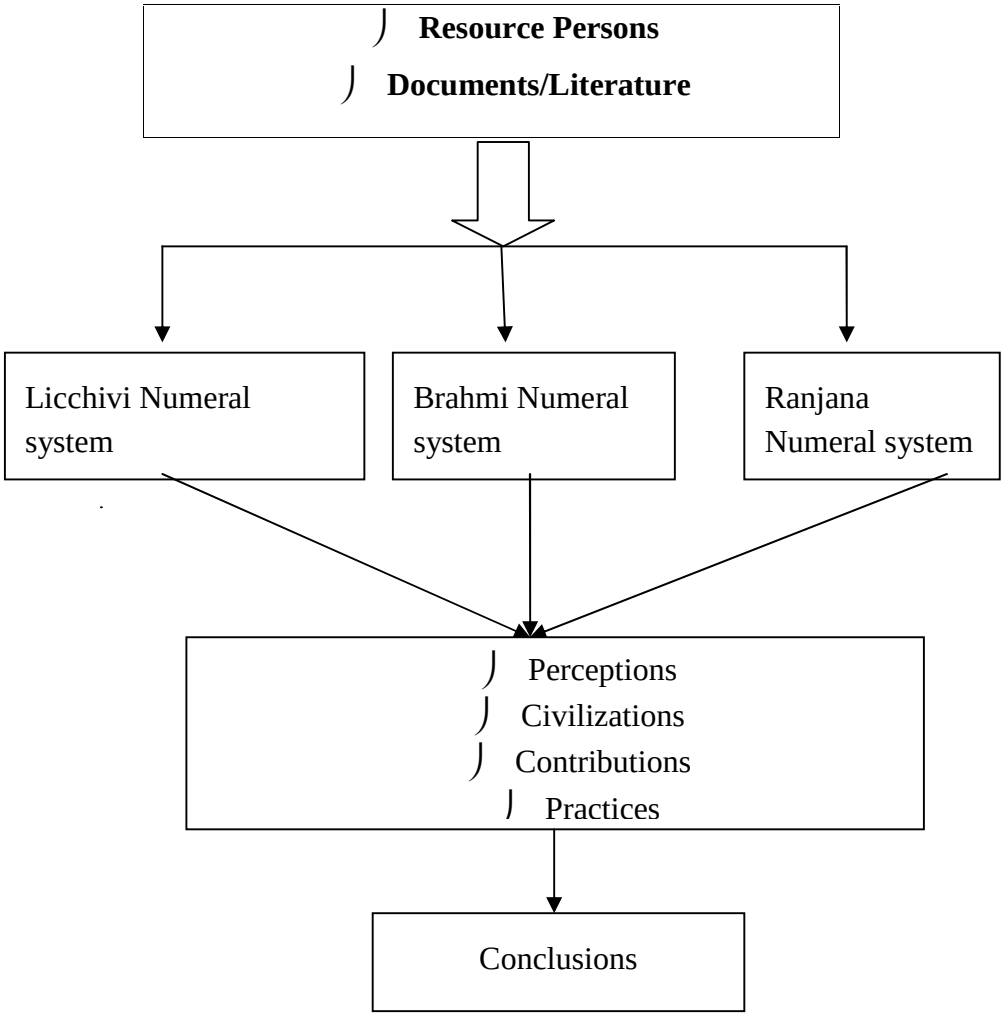
When people feel to symbolize the notation of number, they can choose between two different procedures. One, which can be called “cardinal” consists in adopting symbol for 1, 2 … the other which can be called ordinal consists in assigning to the consecutive whole numbers beginning with 1, the number consisting only on two digits, five digits, ten digits etc. Are the number which are mention as below:-

1. Binary number system
2. Quinary number system
3. Decimal number system
4. Hindu Arabic number system etc.

Conceptual Frameworks

The topic of this study is "Development of Number System in Nepal" it is one of the historical study and it is based on the document analysis qualitative research design. So, researcher applied the following framework for data collection and analyze process.

Fig No. 1: Conceptual Framework



This conceptual framework based on empirical literature review, tries to explain an idea for the study of this research.

The top of the figure above shows the first phase of the study, in which the researcher collects information from resource individuals and books, journals, and other publications concerning the history of mathematics, particularly the evolution of number systems in the global and

Nepalese context. Then, research and represent the many numerical systems in the worlds that provide information about the number systems that exist in the world as well as the developmental stages of number systems.

In the second stage, the researcher will examine and gather information about the Nepalese number system. In the third phase, use pictorial evidence to assess the Nepalese numerical system based on perceptions, cultures, and contributions of mathematicians' practices of the number system. Finally, summarize all of the above facts.

Filling the Gap

This is the age of information and communication technologies. Many new mathematical knowledge and mathematical creations have been developed. Everyone is talking about ICT and inventions, and the foundation of today's mathematical innovations is ancient mathematical knowledge gained by our ancestors. Our most precious asset is our history which provides the door for new knowledge to be discovered. Researcher studied and evaluate a lot of literature regarding the number system, and Researcher discovered that they are doing research on the entire world's number system. As a result of this research, Researcher analyzed the separated number system formed in Nepal as well as the contributions of Nepalese mathematicians to the development of the number system in Nepal. So, Researcher quite excited to study on this topic.

Chapter-III

METHODS AND PROCEDURES

Before entering the research researcher should be sure about the appropriate methods and procedures to collect the data and information about the study. Methods and procedures gives the suitable way of collecting data and interpreted it meaningfully. This chapter describes how the propose of the study conducted in course to achieve the objectives and answering the questions. Method means the way of collecting information from the chosen study and interviews, observation, groupdiscussion, document analysis are the popular methods practices in qualitative research design (Sharma, 2014 cited in Shahi, 2015). This research is a historical qualitative research so, this chapter includes Research design, Sources of data, Area of the study,Tools,Process of data collection and data analysis procedure.

Research Design

The specification of methodologies and procedures is known as research design. It is also a method of research that prepares researchers to reach their study's goal. This study focuses on the development of Nepali numeral system, specifically the three number system Licchivi numeral system. Ranjana numeric system and Brahmi numeral system, both of which can be found in different parts of Nepal. This study's design is historical qualitative research using a descriptive and analytical methodology. The researcher examined and analysed authentic documents such as those of Dr.Eka Ratna Acharya, Ram Man Shrestha, and Nilam Subedi, as well as research journals and conference papers. This research's data is gathered through document analysis, library research, and interviews with resource people.s

Source of Data

The primary and secondary information were the main source of data of this study. . The researcher gathered primary data by visiting manuscripts, biographies, and resource persons, while the researcher gathered secondary data by visiting libraries, websites, and other various records, etc. Secondary data sources include published books, articles, reports, magazines, bulletins, or catalogues, photographs, microfilms, and websites, among other things.

Area of the Study

Development of number system in Nepal was the main area of the study. This study was based on the Licchivi numeral system,Brahmi Numeral system and Ranjana Numeral

system. These numeral systems were logically analyze from authentic historical books, research article and interviews with resource persons. In this study the evidences of the above three numeral system illustrated with pictures and also, mention the contribution of Nepalese Mathematicians Naya Raj Panta,Gopal Pandey,Laxmipati Pandey, Chandrakala Devi Dhananajya, Ram Man Shrestha and so on.

Tools of the Study

This is a historical research based on Qualitativedata. For my research, mainly data were collected from different authentic documents, research journals and articles. Researcher also conduct the unstructured interview with resource person which used the minor source of data.

Documentation Process

First, the researcher gathers documents from libraries and websites and consults with a resource person. To obtain data, researchers used triangulation (several methods of data collecting and analysis). The researcher investigated historical documents, novels, and research journals, among other things.

The study was done using actual historical books and journals published in various publications and locations, as well as the perspectives of three respondents. For gathering data for the study, the researcher primarily refers to the articles "Historical Timeline of Mathematics Practices in Nepal," "Ranjana Numeral System: A Brief Information," "Licchivi Numeral System in Nepal," and "Evidences of Hierarchy of Brahmi Numeral System" by Dr.Eka Ratna Acharya, and "Mathematics Education for Twenty-First Century New Nepal" by Ram Man Shrestha.

First, researcher gathered books, articles, journals, and reports on the history of mathematics, particularly the development of the number system. then th e researcher investigated the world's number system's developmental stage. The Brahmi numeral system is derived from the Devnagari numeral system, but the Ranjana numeral system is derived from the Ranjana script, which is a newari script in Nepal. Similarly, the Licchivi numeric system originated in Nepal, with evidence of it being found in the Changu Narayan temple in Bhaktapur. As a result, the researcher examined all documents related to the Nepalese number system. Devanagari and Brahmi numerals were also developed in South India around a thousand years ago. In addition, the researcher conducted interviews and discussions with resource persons, analyzed the document on the development of Nepal's number system, and

discovered the contributions of Nepalese mathematicians to the creation of Nepal's numeral system.

Document Analysis and Interpretation

The study is historical descriptive in nature. This study's primary data sources were authentic historical books, research journals, and so on. In addition, the researcher gathered the views of three respondents on the study's problem. The researcher interpreted and analyzed the document's viewpoints and triangulates the viewpoint of the resource person.

The related data is interpreted logically, analytically, and descriptively, and evidences were shown graphically. The static data of classical development are extremely rare and do not correspond to historical analysis. The researcher searches many documents and presents a study of the number system evolved in Nepal, concluding with a general inductive method. As a result, the study is descriptive and reliant on historical material. In addition, the researcher follows the advice of the research person when it comes to data analysis and interpretation.

Quality Standards

After completing the construction of the research, it is necessary to maintain quality standard. For the quality standard researcher followed the following ways;

Credibility. The key criterion of the qualitative research is credibility of quality standard. Researcher spent more time developing good relationships and staying close to the resource person during the interview. In addition, Researcher focusd strongly on gathering authentic evidence and analyzing the document with the assistance of my resource person and supervisor.

Transferability. In the positivist perspective, transferability takes priority above external validity. To ensure the validity of my research tool, the researcher creates interview questions based on the conceptual framework. I took images of the evidences, noted the source of each evidence, and recorded the emails with the resource person to ensure the legitimacy of my data.

Dependability. Dependability takes priority over reliability. I took authentic papers connected to my study and consulted with my resource person and supervisor to ensure the

reliability of my data and evidences, and the conclusions of my research are closely related to my resource persons.

Ethical Considerations

Every researcher should be aware of the importance of ethical considerations. It is the researcher's ethnic responsibility. It can be characterized as an essential aspect of the study because research is associated to many parts such as: research document, research participants, resource person, supervisor, and many other related topics. As a result, every researcher should uphold specific ethical norms with connected aspects. Consult with supervisor while deciding on the topic of your research and its aims. At the time of data collection process, Researcher discussed the goals of my research, including my role as a researcher, and obtained clearance from the resource person for interviews pertaining to my study.Researcher cited every document from which obtained information and evidence for this research objectives. Researcher got permission from the library to photograph historical manuscripts, and Researchermentioned the resource person's name by obtaining their okay.

Chapter IV

DOCUMENT ANALYSIS AND INTERPRATION

Data interpretation is the process of reviewing data through some pre- defined process which will help assign some meaning to the data and arrive at a relevance conclusion. Data analysis is the process of ordering, categorizing, manipulation and summarizing data to obtain answer to the research question (Mishra,2017).

The chapter includes a brief overview of three Nepalese number systems: the Licchavi numeral system, the Brahmi numeral system, and the Ranjana numeral system, as well as the contributions of three Nepalese mathematicians to the development of Nepal's number system. For this, the researcher collected approved historical documents, visited numerous libraries, visited various online sites, consulted with resources, and conducted in-depth interviews to obtain credible and factual data, and divided the chapter into two pieces. Section I covered the development of the three numeral system, while Section II discussed the contributions of three Nepalese mathematicians to the number system's development.

Section I: Development of Numeral System in Nepal

This section explains the development of Nepal's number system. Aside from these numerical systems, below is a description of the main numeral systems developed in Nepal, which are: Licchivi numeral system, Brahmi numeral system, and Ranjana numeral system.

Development of Licchivi Numeral System

Licchivi Era.(c.450 - c.750) in Nepal, the period of rule by the Licchivi density. The era. Ended when Amsuvarma founded the Thakuri density in the mid 8Th century (https://www.britannica.com/place/Nepal). Licchivi was kingdom which existed in the Kathmandu valley in modern Nepal. From approximately 400 to 750 CE. Licchavi clan originated from Vaisaili. Where Vaisaili was a city in present day Bihar,India is now anarcheological site(https://en.wikipedia.org/wiki/Licchavi_(kingdom)
The ruling period of this density was called golden period of Nepal. In this period thepeople used the Gupta script .In the famous coin of Amsuvarma there is used the Gupta script.

> *The **Gupta script** (sometimes referred to as **Gupta Brahmi script** or **Late Brahmi script**)[6] was used for writing Sanskrit and is associated with the Gupta Empire of India, which was a period of material prosperity and great religious and scientific developments. The Gupta script was descended from Brāhmī and gave rise to the Angara, Śāradā and Siddhaṃ scripts. These scripts in turn gave rise to many of the most important scripts of India, including Devanāgarī (the most common script used for writing Sanskrit since the 19th century),*

the Gurmukhī script for Punjabi, the Bengali-Assamese script and the Tibetan script. (https://en.wikipedia.org/wiki/Gupta_script).

Figure no.1: Coin of Licchivi King Amsuvarma, 605-621CE (https://en.wikipedia.org/wiki/Licchavi_ (kingdom)

The figure no.1 shows that, in licchivi era. there is used the Gupta script in Coin and the coin is famous in the period of King Amsuvarma.And the following Figure no.2 shows

the Gupta script. Which was used for sanskrit and associated with the Gupta empire of India.

Figure no.2: The Gopika cave inscription of Anantavarman in the sanskrit language and using Gupta script.barbar caves in Jehanabad Bihar, (5^{Th} or 6^{Th} century CE.) (https://en.wikipedia.org/wiki/Gupta_script)

On the relation of Licchivi numerals and Gupta Script Responder-A express the view as below:

"*The counting system of object is developed from the ancient human civilization. In the Nepalese context mainly there are Licchivi, Ranjana and Brahmi numeral system as well as we can say that the Kharosti numeral system is also affected in Neplalese numeral system. The Licchivi Numeral System not directly came from the Gupta script but it is closely related to Gupta script of South India."*

Purva Licchivi Script

The script was used in the Licchivi kigdom between 400 AD to 500 AD to write Sanskrit, Newari and Bajjika. It is also known as the pro-Licchivi script and it is closely related to the Gupta script.It is left to right in horizontal lies.(See Appendix-A)

Licchivi Numeral System

Licchivi numeral system is based on positional number system, sign value system,decimal value system,unarary system and grouping system. According Historical Time Line of Mathematics Practices in Nepal (Achaya, 2017): In ancient period (Licchivi) people were used different system of measurement like *Manika* to denote the quantity of

paddy land covered by the seed of one *Manika.* In the now days also *Mana,Pathi,Muri also* used to measure the paddy.

In Licchivi inscriptions various symbol were used as numerals to the records of works. The numbers 386 is denoted by the following symbols at Changu Narayan Temple at Bhaktapur**:**

Figure no.3: Numerals in a stone in Chnagu Narayan Temple (Source: Acharya, 2017)

The above circled symbol is shown in the following figure:

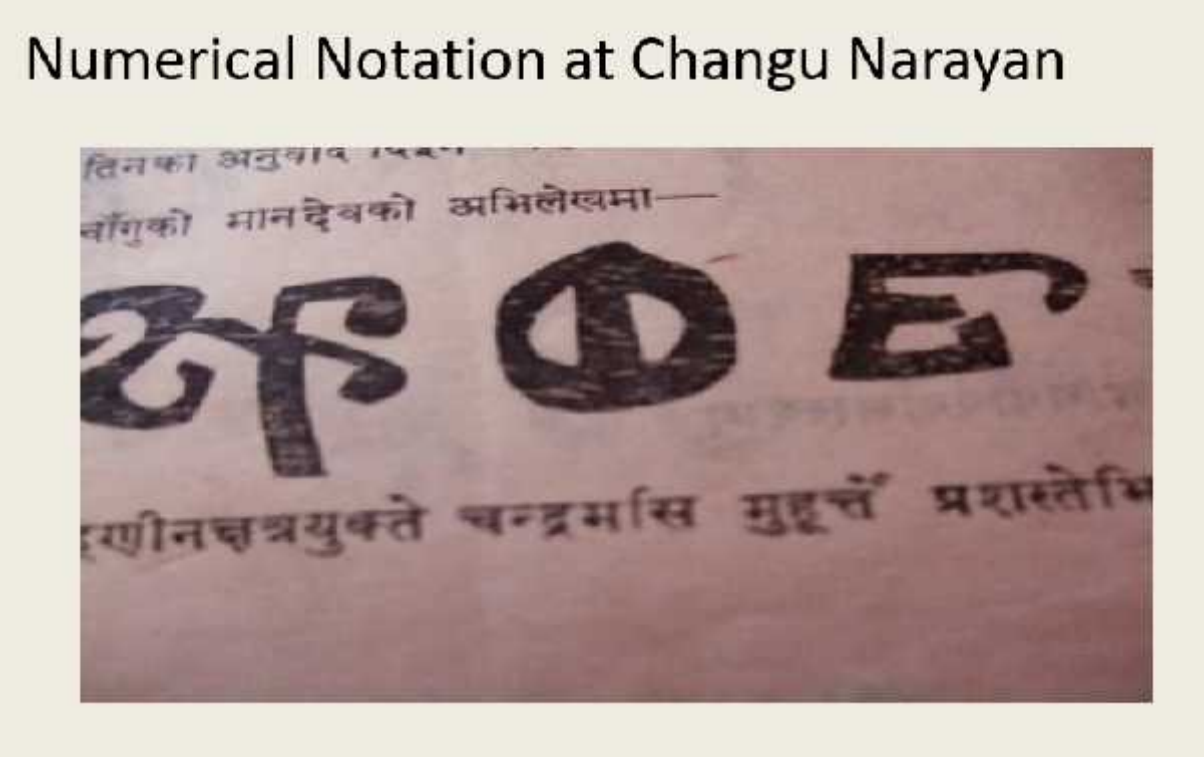
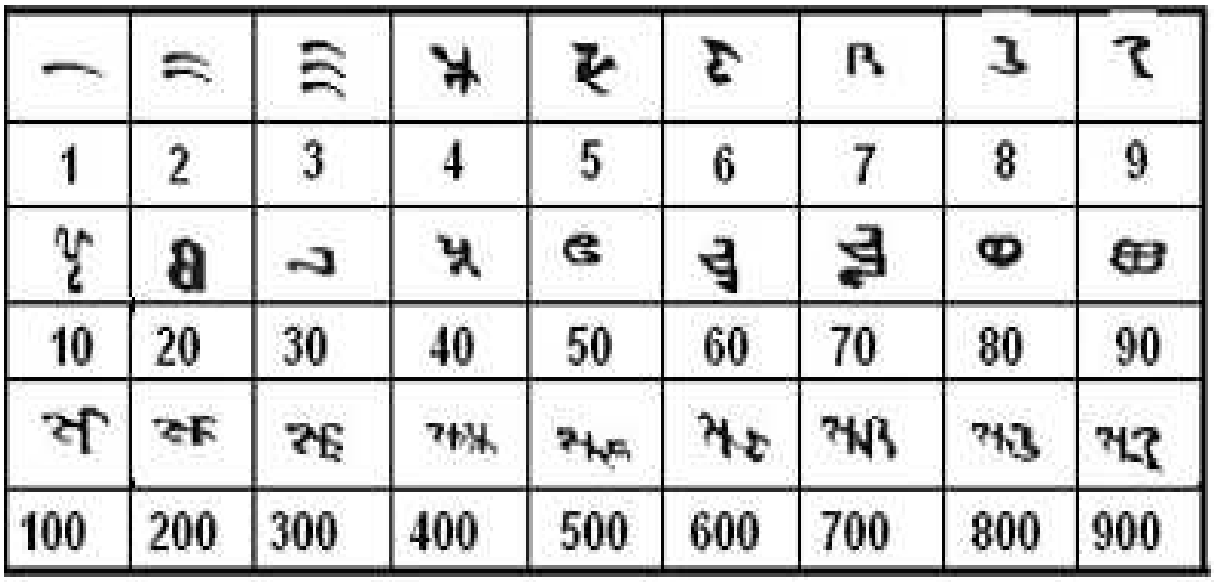


figure no.4: Numerical notation at Chanu Naryan Temple at Bhaktpur (Source: Acharya,2017)

Further he says that, In notation system there were one ligature for 100, two ligature for 200 and three ligature for 300 Inscriptions on the base of the Jaya Varma statue at Maligaun, Kthamndu.The symbol in this stone states Saka Sambat 107 (See Appendix -C).

According to a journal "Licchivi Numeral Syatem in Nepal" by A.R. Acharya, In Licchivi period there were no symbol of zero but the concept of zero was raised as the emptyness. Nepali or Licchivi number system based on place value system as Hindu-Arabic numeral system and Brahmi numeral system. It has numeric symbols in left to right decreasingmagnitude order. It followed the theory of one to one correspondence and the nature of numbers counting principles eighth peano's Axioms for succession of number and It is both additive and multiplicativenature. Following table gives the selection of Licchivian

Numerals:



1	2	3	4	5	6	7	8	9
10	20	30	40	50	60	70	80	90
100	200	300	400	500	600	700	800	900

Figure no.5: Licchivian Numerals (Source:Shrestha,2017)

Shrestha further writes, each unit (1, 2, ..., 9) was assigned a separate letter, each tens (10, 20, ..., 90) a separate letter, and the hundreds (100, 200, ..., 900) a separate letter with the unit symbols for 1, 2, …, 9 attached with or without a small ligature to the new symbol for hundred

Development of Ranjana Numeral System

Ranjana script is a Brahmi script which is developed around 1100 C.E..It was used in India and still used in Nepal by the newari people to write newari language. It is considered as one of the script in Nepal . It is also called *Nepal Bhasa* Literally *'Nepal- Language'* .It is different from Deveganari script.Use of these scripts began to decline after the Gorkhali conquest of the Kathmandu valley in 1769 and they are now used. It is related to the Tibeto-Burman language unrelated to Nepali.The script was derived from Brahmi via the old Nepali script.The Ranjana is written using from left to right. It must be written using calligraphic implemented as the thickness of the stroke's is important. The Ranjana script is the formal script of Nepal duly registered in the United Nations while applying for the free notation. Thethe evidences of Ranjana script (See appendix-C)

Ranjana Numeral System

Ranjana numeral system were developed from the Ranjana script.It is the Nepali numeral system. It is popular in Nepal Bhasa language(Newari Language).According to the journal of E.R.Acharya"Ranjana Numeral System: A Brief Information", the Ranjana

numeral system gives the Nepal's own scenario in the field of numeral system. This is the single script that written with gold in the *Pragyaparmita* contains 2032 pages with 4 volumes. This numeral system is related with Brahmi numeral system, Which was developed at 3rd century B.C.

Regarding on the development of Ranjana Numeral System Responder-A gave the views as below:

"The Ranjana Numeral system is still used in Nepal as Newari language. Specially in the kathmandu valley the people used the Nepal Bhasa (Newari Language) in their conversation and their religious writing. There is the textbook of Nepal Bhasa in some school of Kathmandu Valley. The Ranjana script is registered in UN as Nepal Bhasa. About the Nepalese numeral system prof.Dr.Eka Ratna Acharya presented his Post Dr. research in Greece but other numeral system cannot globalize yet." (12th Baishak, 2079)

The following photograph illustrate the Ranjana numerals with zero. The numerals zero(0) was popularly used but its development only different assumptions were appeared. Here this photograph contains the symbol of zero(0).

Figure no.6: Ranjana numerals (source:https://omniglot.com/writing/ranjana.htm)

Acharya, explore that the Ranjana Numeral System contains the symbol of zero.It is parallel of Brahmi and Licchivi numeral system espically in Nepal.The characteristics of Ranjana numeral system are mention as follows:

(i) Type of writing system: syllabic alphabet-each letter has an inherent vowel (a). Other vowels can be indicated using a separate letters.
(ii) Direction of writing: left to right in horizontal lines.
(iii) It contains the symbols of zero (0).

(iv) It is Nepal's indigenous developments in the field of numeration system and hence is as the fundamental elements of mathematics developments.

v)It impacts the neighbors to develop the script of language.

(vi) It gets the warm lap of one of the large script system 'Ranjana Script'.

It shows that the Ranjana numeral system is a Nepal Bhasa (Newari), a member of the Tibeto-Burman group of Sino-Tibetan languages spoken in Nepal, India, Sikkim and West Bengal, and Bhutan by about 800,000 people. As well as the Ranjana script, Nepal Bhasa has been written with the Brahmi, Gupta, Prachalit, Bhujimol and Devanagari script used to write Sanskrit, the classical language in Bharatavarsa. Ranjana numeral system's origin is in Nepal with Nepal Bahasa. It contains 10 numerals with the symbols of zero (0). Perhaps Ranjana numeral system occupied the lap of the largest script Ranjana in Language script that focus its importance.It is also called the Ranjana numeration System is the product of Brahmi script (Adhiakri,2059).

Development of Brahmi Numeral System

The Brahmi numerals are the numeral system attested from the 3rd century B.C.E.They are non-positional decimal system (https://en.wikipedia.org/wiki/Brahmi_numerals).The Brahmi numeral came from the Indus valley culture of around around 200 B.C.The Brahmi numerals comes from Aramean numerals. It is came from Kharosti alphabet and Brahmi alphabet. Also it came from egypt

(Cannor and Robertson,2000).Here is the Brahmi numerals from the 1st century .

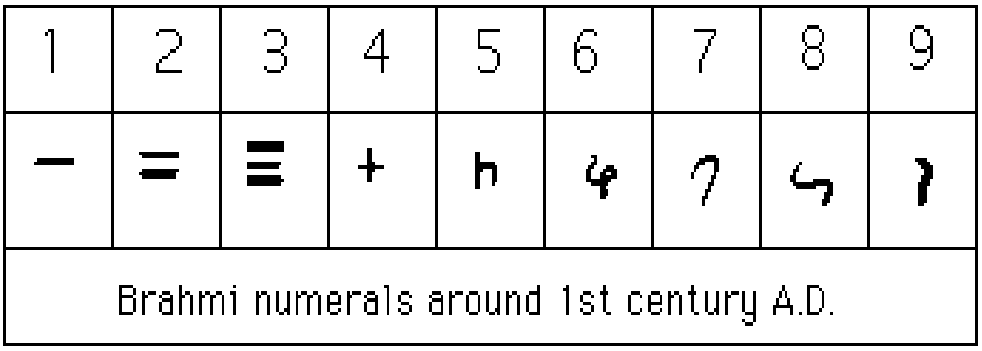


Figure no.7: Brahmi numerals around 1St cenury (Source:Cannor and Robertson,2000) (See Appendix-E)

The Brahmi numerals are an indegenious indian numeral system.They are direct graphic ancestors of the modern Indic and Arabic numerals. However, they were conceptually distinct from the these later systems as they were not used as a positional system with zero. There were separated Brahmisymbols for 4,5,6,7,8,9 but there were also symbol for 10,100,1000…… as well as 20,30,,40,90 and 200,300,400 ……..900.Here is the Ancient non-zero and zero place holder numeral system of Hindu-Arabic and Brahmi numerals.

Figure no.8: Ancient non-zero and zero place holder numeral system

(Source: (https://en.wikipedia.org/wiki/Brahmi_numerals).

Brahmi Numeral System

According to the " Mathematics Education in Twenty First century new Nepal" by R.M. Shrestha,The written form of number words or numerals first appeared in the Brahmi script.In the context of Nepal Brahmi numeral did appeared in groups or installments in the edicts as the evidence from the inscriptions left Ashoka from around middle third century

B.C.E or toward the end of period of the Vedic Sulvasutra era. Following figure shows the Evidence of Brahmi numeral in Ashoka pillar in Lumbini:

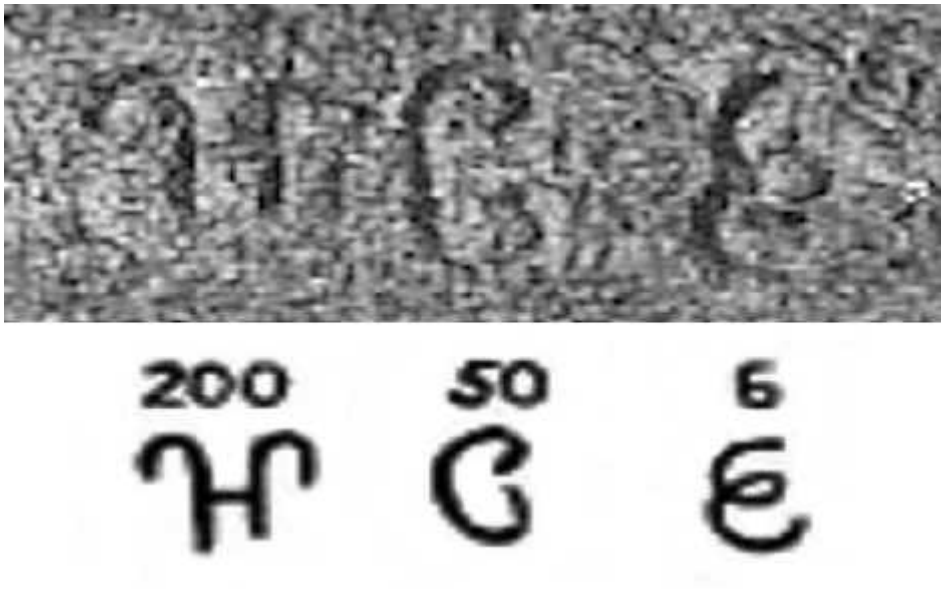


Figure no.9: Brahmi Numerals inAshoka Piller(Source:Shrestha,2017)

The above figure shows the numerical evidence in the Ashoka Pillar of Lumbini ,Nepal.

Regarding on the Licchivi numeral's evidence the Responder-C gives the view as below:

" *There are different -different symbols and languages to denote the numbers in different cast and culture. The evidence of Bahmi numerals in Ashoka Pillar of Lumbini Nepal and the Symbol of Ranjana numerals found in Bhaktpur Darbar Square area."(1st jesth,2079).*

According to the A.R Acharya"Evidences of Hierarchy of Brahmi Numeral System" the reliable source for Brahmi and other inscriptions is the pillar prepared by Ashoka(300 B.C.E).There is the no symbol for zero in Brahmi numeral.So due to the lack of zero was no any huddle in this system.Brahmi numeric symbols were found as the first written mathematical documents on Ashoka pillar at Lulmbni,Niglihawa of Nepal. Asokainscriptions in Brahmi dated to 232 B.C.E. In Ashoka pillar there were found the word numerical "*Atha Bhagiya*"thisword used for the division by eight i.e. (1/8).This gives the concept of division by 8 and conversely multiple of 8.

Also,Acharya explores that the Brahmin inscription system is popular in Nepal and India as well as Pakistan. It is a indigenous South Asian sabconential numeral system which

was popular in South Asian sub-Continent.It is also called that the Brahmi numeral system is the root of the other numeral system.

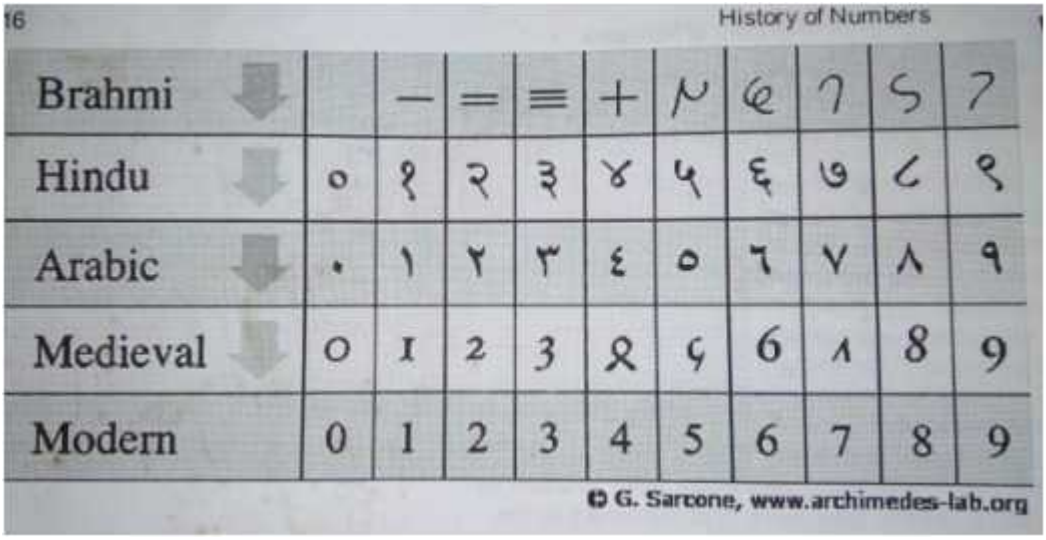


Figure no.10: Developing phase of modern Hindu-Arabic Number System (http://vedicscience.net/articles/history-of-number.html)

The above figure no.10 shows the todays modern Hindu-Arabic number system is comes from the Brahmi numeral system. This we conclude that, Brahmi number system is the fundamental basis of Hindu-Arabic and Devanagari number system. Similar hieroglyphs was explained by Roger Cooke in the book, A History of Mathematics‟ (Cooke, 2005)

After analyzing theresponders view and the above evidences of three numeral system, researcher has got the conclusion as that there are many numeral system in the world such as: Babylonian numeral system, Egyptian, Greek, Brahmi, Kharosti, Licchivi, Ranjana, Chinese, Devnagari, Hindu-Arabic numeral system etc.(Yadav, Acharya, Sharmaand Chhetri,2018). Among these numeral system the three numeral system: Licchivi numeral system, Ranjana numeralsystem and Brahmi numeral system were basically developed in Nepalese context. In ancient perod of Nepal. The Licchivi numeral system was developed in Licchivi Era in the period of Licchivi density. The Licchivi numeral system were based on Gupta script. And the Ranjana numeral system is comes from the Ranjana script(Nepal Bhasa). It is recently used in Nepal as Nepal Bhasa as Newari lanuguage.It has own symbol of Vowel and constant letter as well as numeral symbol also. Similarly the Brhami numeral system were developed from third century B.C.E as non positional number system. It is called the base of the all numeral system.In the Nepalese context symbol of Brahmi numeral found in the Asoka pillar of Niglihawa Lumbini Nepal I around 3rd century.

Section-II: Contributions of Nepalese Mathematician in the Development of Numeral system

Gopal Pandey and his Contributions in Mathematics

According to the journal paper of S.M. Maskey "Mathematics in Nepal" Pandit Gopal Pande (c. 1847-1920) was a pioneer teacher, Mathematics textbook writer and astrologer of Rana Regmi period. He served as a mathematics teacher for 42 years at Sanskrit Pathsala at Jamal, Kathmandu.The deputation of Pandey as the mathematics teacher at Sanskrit Pathshala by the Rana Rulers was their awareness towards the importance of mathematics as an allied subject in the oriental system of education to support the education of astrology/astronomy and daily affairs. Rana Prime Minister Chandra Shamsher being the Matriculation Examination Graduate, he assigned Pandey as mathematics tutor for his family members at his Singh Durbar residence. It motivated his high level officers as well to educate their children with the subject of mathematics.

Also, According to the Article paper "Gopal Pandey: The first Mathematician of Nepal" by E.R acharya (2013),Pande is the first mathematician and writer of mathematics book in Nepali language among the known mathematicians of Nepal.He wrote a book *Wyaktachandrika* in 1888 A.D. It was published in locally manufactured *Nepali Kagaj*. So,*Wyaktachandrika* book taken as a milestone in the history of mathematics because in that time the printing machine also arrived in Nepal.The subject matter contained in the book was updated version of *Liavtai*.Pnade had written various books of mathematics which were very popular in Nepal and India.The most important work of Gopal Pande in mathematics was the concept of rule of three square root and cube root.A unique technique of finding the cube root of a positive integer developed by Pandey demonstrated his keen interest in exploring something new derivation in mathematics. The writing of two other manuscripts in Hindi language entitled Lokaanusmriti -nf]sfg':d[lt_ and Vhubhraman beechar -e"e|d0f ljrf/_ justified that he was a person of multi-dimentional talent etc.

Laxmipati Pandey and his Contributions in Mathematics

Laxmipati Pande (1758-1813) was the astrologer and Mathematicians. He advised king Prithibi Narayan Shah So, he is honoured as a royal astrologer.He is in the mediaveal period Mathematician. In the mediaval period the mathematician mainly contributed in Jyotisha arithmetic and they calculated calenders and it is based in planetary motion that is

astronomy. Laxmipati Pande is found to be the first astrologer that has written in Nepali meaning of his slokes (http://globalastrologer.blogspot.com)

According to a workshop paper "The Historical Development of Mathematics " by E.R.Acharya the contribution of Laxmipati Pande in mathematics as follows:

- Laxmipati Pande is not only mathematicians, he is also astrologer. He has written solar watch.
- He had written the commentary of Bhaswati and started his mathematics and jyotisha study.
- He wrote *Bhaswati* which is the initial textbook of mathematics in Nepal. Astrologer had calculated planets-satr colander and ellipse on the basis of this *Bhashwati.*
- He wrote about 40 books. Some notable books are*:Ratnadip,Lilavati,Bhashwati Tika*etc. We can find list of about 40 books that was either occupied or written by Laxmipati Pande in *Laxmipati Pande Sanghra.*

According to a journal paper"Mathematics in Nepal" by Shantosh Man Maskey,Laxmipati pandey is a royal astrologer. He started his profession of *Jyotissi* at the age of twenty. The most important work of Laxmipati Pande is Sundial crave on stone of Swoyambhu complex during the period of king Pratap Malla(1641-1674).In 1911 Rana prime minister Chandra Shamsher created Sundial manufactured in U.K.in the premise of Tri-Chadra college on the eastern side of Ranipokari, Kathmandu.

Naya Raj Panta and his Contributions

Naya Raj panta(1912-2002) was an enitment historian ,astrologer mathematician and Sanskrit scholar of Nepal. He was born at Mahabouda, Kathmandu. He is called the Socrates of Nepal. He was also nominated as the member of Nepali Bhasa Prakashani Samiti Mandal.He worked as a Researcher in Balmiki Vidhyapith from 2033 B.S. to 2035 B.S. He was ancient scholar of Mathematics in Asia. He was the self-learner and seen very much inquisitive in Mathematics and Jyotisha Ganita. He was also honored by king Mahendra by nominating him as the member of Royal Academy in 1979 (Maskey,2010).

According to the conference paper "Historical Development of Mathematics" by E.R. Acharya, professor Panta was a awarded so many times due to his pioneer works in the field of research and publication with teaching Jyotisha Ganita.He is also a great astrologer and Mathematicians. His contributions are mention as follows:

- He was praised as a great astronomer and mathematician by foreign scholars.
- He was awarded so many times due to his pioneer works in the field of research and publications with teaching Jyoutisha Ganita.
- He revised the Gopal Pandey's rule of calculation of cube roots by applied the rule of three.
- He used the rule of three to calculate the square root.
- He explored the contributions of Gopal Pande and Laxmipati Pande.
- He wrote the commentary and modifications on some mathematics developed by Bhaskaracharya.
- He gives the connection between ancient and modern mathematics.
- He revised the calculation of calendars.
- He wrote the following books: Jyoutisha, Pandit Gopal Pande and his rule of calculation of cube roots, Comparisons of ancient and new (modern) mathematics, Comparisons of Hindu Siddhanta Jyoutisha and Greek Siddhanta Jyoutisha, Declaration of Lichhavi Era, Laxmipati Pandey's Sundial, Sumati Tantrum, Ratna Dip part one and two, Golbodha, Kalachakra and its analysis (part I and II), Trigonometry, etc. and he has written hundreds papers of mathematics and commentaries.
- He identified Lichhavi numerals used these symbols in representation of pages of a book.
- He identified the birth place of Śripati and highlights his work Siddhantasekhara.
- He presented 62 talks at Nepal Academy and he has nearly 200 mathematical papers and books.
- He is as the mathematician and historian of mathematics.
- He planned the observatory for observing solar systems.

To summarize, Prof. Naya Raj Panta was a great Nepalese astrologer and mathematician. The publishing of Pant's monumental works in mathematics serve as resources for the development of Nepal's medieval mathematics history. He was not just a person, but also a

20th-century institution in the fields of ancient mathematics and astronomy. After evaluating the contributions of three Nepalese mathematicians, the researcher found that mathematicainas were astrologers more than mathematicians in the ancient time. In astrology, they applied their mathematical understanding. They wrote numerous books on astrology, planet research, elliptical study roots of numbers, and so on. Their impact on the growth of mathematics in Nepal is significant and essential for other Nepalese mathematicians.

Chandrakala Devi Dhananjaya

She is first woman mathematician/ writer of mathematics in Nepal. She had written SishubodhTrangini part one and part two. She express a prosody of mathematics.

Ram Man Shrestha

Professor Dr. Ram Man shrestha is the founder president of Nepal Mathematics. His many research works and books related to the mathematics were published. From his book "Mathematics for twenty first Century" he explores about the different numeral system in the word as well as in Nepalese numeral System.

Eka Ratna Acharya

Eka Ratna Acharya (2023 B.S.) is a professor (PHD and Post Doctor)of University Campus, FOE (Tribhuvan University) Kirtipur Kathmandu,Nepal.The main area of specialization in the sector of mathematics is history of mathematics, mathematical Real Analaysis, Algebra, Graph Theory and vector analysis etc. He is the founder of Nepal Mathematics Center and many other mathematical organization.

He presented many papers seminar paper related to the Mathematical knowledge.He had done collectively more than 100 national and international simple research publications. In sum up, Acharya explores about the numeral system and historical development of mathematics. And overall it concluded that the classical mathematicians also exploring the historical study of Mathematics.

Neelam Subedi

Neelam subedi is a Associate Professor of Janamaitri Multiple Campus (Tribhuvan University), Kathmandu, Nepal.She has done her P.H.D. research on the topic"The development of Numeral syastem in Ancient Nepal". On this research she explore the satage

of development of numeral system and bases of number system. Her speceilization sector of Mathemetics is History of Mathematics.

Interview with Resources Persons

The researcher put his problems and curiosities toward “Development of number system in Nepal” with some related resources persons. Researcher prepares a list of unstructured interview schedule (See Appendix-A) to collect information to make authentic the study. Here, three resource persons have been selected given the name as responder-A, responder-B, responder-C. Their name put secret for ethical consideration. Unstructured interview was conducted with resources persons to provide authentic and valid the study. Researcher cross matched the response of resources persons with the views of documents. At last, researcher reached in valid conclusion. (See Appendix-F)

Chapter V

FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

This chapter deals with the findings, conclusion, implication drown from the study and recommendation for the further study.

Findings of The Study

The historical study is descriptive and analytic in nature, with the goal of analyzing the evolution of the number system. The primary goals of this research were to investigate Nepal's numeral system and to examine the role of Nepalese mathematicians in the development of mathematics in Nepal. To achieve these goals, the researcher studied and analyzed various resources, as well as interviewed resource people. Because the study was historical and qualitative, the researcher conducted unstructured interviews with three separate resource people and analyzed the study's documents. From these method and procedures researcher has point out the following findings:

- The human natural number sense is used for only recognizing the objects. The number perception is arising from the logical thinking on the objects. Animal has the number sense. For example: crow has number sense up to 4, dog has number sense up to 10, but human have advance number sense.
- Numbers are come from human culture and civilization not the contributions of mathematicians. But numerals are developed from people's insight on objects of graphical sign. A person makes number sense from define collection of objects. They make sense of one from the unique objects likes “sun”, “moon” etc., sense of two from the collection of two likes “eyes” and “breast” and so on.
- Ancient people associate one pebble for one sheep, another pebble for another sheep then make counting sense. Thus, the modern counting was developed from ancient people's one-to-one corresponding counting techniques.
- The symbolization of numerals were different by civilizations and culture of human. They symbolized by own rules and knowledge.
- According to the resource persons and authentic documents; Licchivi numeral system is developed from Licchivi Era. The period ruled by the Licchivi density. The Licchivi numeral comes from Gupta script .In that time Licchivi numerals famous Amsuvarma coin. The evidence of Licchivi numeration found in Changu Narayan

Temple in Bhaktpur.In the Licchivian number there is not used of zero but the concept of zero is developed.

- Ranjana numeral system is Brahi script literally used in Nepal as well as India. Ranjana numeral system is related to Tibeto Buman language unrelated to Nepali. The Ranjana script in duely registered in U.N. while applying for the free notation. It is still used in Nepal as *Nepal Bhasa*(Newari Language) and there is used of the symbol 0 in numeration.
- Brahmi numeral system came from the Indus valley culture around 200 B.C.E . It is a combined form of Kharosti alphabet and Brahmi alphabet. It is indigenous Indian numeral system. The evidence of Brahami numeral in Nepal found in Ashoka pillar in Lumbini Nepal. There is found the word "Atha Bhagia"which is used for divided by 8.
- Gopal Pande was known as the first mathematician of Nepal. He wrote a book *Wyaktachandrika* in 1888 AD . The subject matter contained in the book was updated version of *Lilavati* . The most important work of Gopal Pande is rule of finding square root and cube root of numbers.
- Laxmipati Pande was the astrologer and mathematician in the Mediaval period of Nepalese history. He was written *Solar Watch* also he wrote the *Bhaswati* which is the initial mathematics written text book in Nepal.
- Naya Raj Panta was an intment historian, astrologer, mathematician and Sanskrit scholar of Nepal, He did remarkable works in the development of mathematics in Nepal. He used the Licchavi numerals for representing pages of the book.
- Finally, the evidence of numeral system were presented with explanation in the previous chapter.

Conclusions of the Study

The number is the result of a social phenomenon. Based on the findings, the researcher concludes that number perception is created by rational reflection on the things. The concept of numbers and numerals dates back to early human culture and civilization. So, the number is a creation of several human civilizations but not of mathematicians. This is similar to the numeral system as well. The human natural number sense is only employed to recognize objects. At a look, the human direct number sense can distinguish a collection of less than four things. Modern counting developed from one-to-one equivalent counting procedures

used by ancient peoples. Numerals evolved from several graphical signs used by ancient cultures.

In this sense, every human civilization develops its own counting system. The Nepalese numeric system has its own number symbolization, such as the Licchivi numeral system, Ranjana numeral system, and Brahmi numeral system. These numeral systems are the South Asian subcontinental numeric system and are strongly tied to the Indus Valley civilization and directly related to the Indian numeration system. These systems were largely employed in Nepal, India, and Tibet. Nepalese and Indian mathematicians have made significant contributions to the development and globalization of the numeral system.

The current Devnagari and Hindu-Arabic numeral systems are based on an older number system. Overall, it is concluded that the number system is an integral element of a language and should be described in the same way as the rest of the lexicon in terms of syntactic construction and internal morphology. So, in order to investigate indigenous knowledge of mathematics and local numerical system, study in the field of indigenous numeral system should be conducted, published, and practiced beginning in basic school.

Implications of the Study

Every research has implication in different sectors (Shrestha,2016).The study entitled "Development of Number System in Nepal" has also implication in different sectors. The major focus of the study is the Development of numeral system in Nepal and the contribution of the Nepalese mathematicians in the development of mathematics as well as in numeral system.This is a qualitative research and historical descriptive based on content analysis methods. Primary and secondary data were used. The source of data for this study were taken from historical documents, archives, websites, research article, related journals, authorized books, consulting with research persons, libraries, Development of Number,department of archaeology etc. The researcher used open-ended interview with recourse persons. The major implication of the study is helping the historical researcher towards the indigenous mathematical knowledge and those researcher who wants to study about the cultural mathematics. According to finding and conclusion of this study, researcher expects the implications as:

- This study epically explores the three numeral system developed in Nepal so, it helps to those researcher who wants to study about numeral system in Nepal.
- It helps to study about indigenous and cultural mathematical knowledge.

- It provides information to math teacher an students who studied about the history of mathematics.
- This study explores the different evidence and fact about numeral system.
- This study might be supportive document technically and academically basis of the number system.
- The finding and conclusion of this study other researcher could be curious to research and documenting creations of the other numeral system.
- This study helps those learners who wants to study about Nepalese mathematicians and their contributions in the development of Mathematics and numeral system.
- On the whole, the research will help those researcher doing research on the today onward.

Recommendations for the further research:

No research iscomplete itself. It cannot be said that the finding of any research done by selecting samples from within certain limits are universal accepted. Any of the research doesn't give only new findings but also take out new problems and issues. The study was based only the three numeral system in Nepal and the contribution of three Nepalese mathematicians in the development of mathematics and numeral system in Nepal. It did not tell about the other indigenous numerical system because Nepal is a multicultural, multireligion, multicast and multilanguages country so, here is the different -different symbol and system for symbolizing and representing numbers.Thus, further research needed in this direction and more research is expected. Further recommendation is presented as follows:

- It should be study other number systems used in other ethnical group of community such as: Sanskrit language, Kirat language, lama language etc.
- It should study comparatively between historical development of Nepalese numeral system and Devanagari numeral system.
- It should be study comparatively between historical development of numeral system and indigenous Geometrical knowledge in Nepalese ethnical community.
- It should be study about mathematical contribution of other Nepalese mathematician in the development of Mathematics and numeral system in Nepal

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Appendix-A

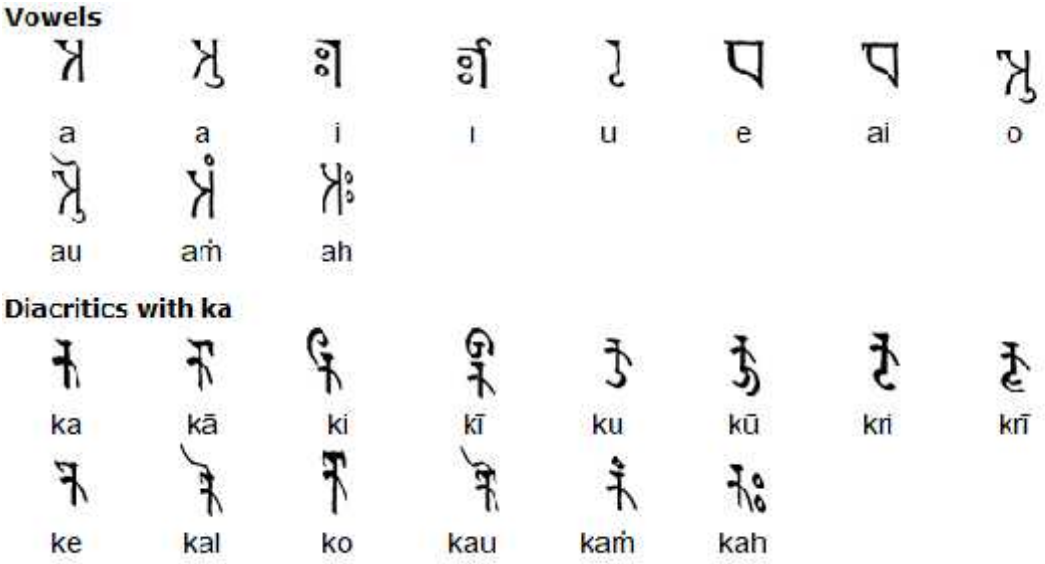
Interview Questions:

In order to collected data , I had conducted semi-structured interviews on the basis of interview guidline.The research is based on discriptive and analytical approach. So, interview guidline for resource person are as below:

- Is the numeral develops from human culture and civilization?or from mathematicians? Should provide views behind it.
- Are there different numeral system developed in Nepal; What are they?
- Is the Licchivi Numeral system,Brahmi Numral system and Ranjana numeral System are the Neplaese numeral system? Should provide evidences.
- Who were the main contributors of Neplease mathematicians in the development of the numeral system in Nepal?
- What are the main area of contributions of Neplaese Mathematician in the development of numbar system in Nepal?
- Is these numeral system:Licchivi,Ranjana and Brahmi are still existed in the practices in Neplease numeral system?
- Is the Neplease numeral system globalized?
- What are the evidence or bases of Licchivi,Ranjana and Brahmi numeral system ?
- Is the Licchivi numeral system comes from the Licchivi era. on Gupta script?
- Is the Ranjana numeral system comes from on Ranjana script or Newari lanaguage?
- Is the Brahmi numeral system comes from the Devnagari numeral system?

Appendix-B

Purva Licchivi Script of vowel



Source:https://omniglot.com/writing/purvalicchavi.

Purva Licchivi Script constnatns

Source:https://omniglot.com/writing/purvalicchavi.

Appendix-C

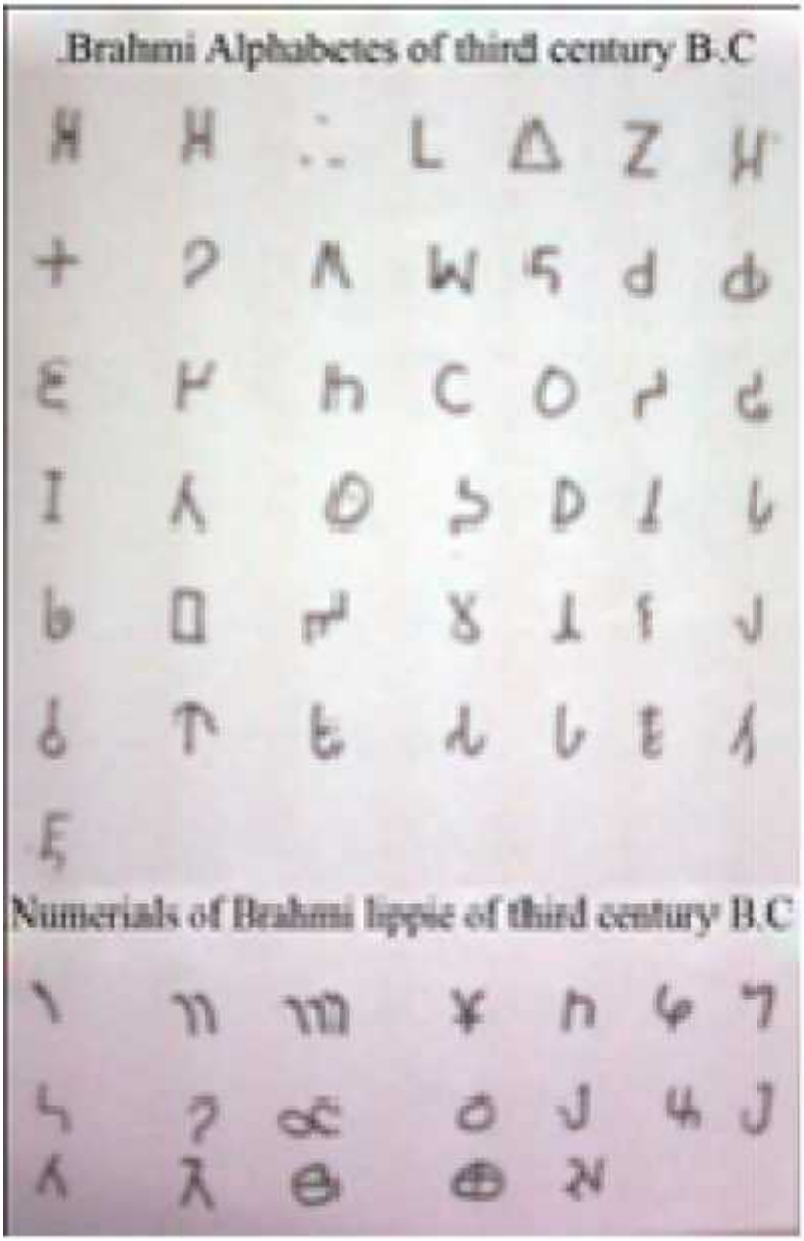
Vowel Letter of Ranjana script(source:https://en.wikipedia.org/wiki/Ranjana_script)

Constnatnt Letter of Ranjana script (source:https://en.wikipedia.org/wiki/Ranjana_script

Appendix-D

Source: Inscriptions of Jaya Varma at Maili Gaun,Kathmandu (Acharya,2017)

Appendix-E



Brahmi Alphabt and numerals (Source:Acharya,2017)

Appendix-F

Tribhuvan University

University Camus

Department of Mathematics Education

T.U.Kirtipur, Kathmandu

Dear sir/Madam

I am a student of Master's Degree in Education. I have chosen topic "Development of Number System in Nepal" for the partial fullfellment of Master's Degree in Mathematics Education.The interview quetionare are designed as open-ended. Your valuable view and perception will contribute a lots of information for this study.I humbly request for reimburse the permission to use up your response in this research if required.Your view and openion are be used only for the research purpose will not be made public.

Thanking for your kind co-operation for giving your valuable opinions.

Your Sinceraly

(Mina Karki)

Appendix-G

Resopnder:A

"The counting system of object is developed from the ancient human civilization. In the Nepalese context mainly there are Licchivi, Ranjana and Brahmi numeral system as well as we can say that the Kharosti numeral system is also affected in Nepalese numeral system. The Licchivi Numeral System not directly came from the Gupta script but it is closely related to Gupta script of South India. The Ranjana Numeral system is still used in Nepal as Newari language. Specially in the Kathmandu valley the people used the Nepal Bhasa (Newari Language) in their conversation and their religious writing. There is the textbook of Nepal Bhasa in some school of Kathmandu Valley. The Ranjana script is registered in UN as Nepal Bhasa. About the Nepalese numeral system prof.Dr.Eka Ratna Acharya presented his Post Dr. research in Greece but other numeral system cannot globalize yet." (12th Baishak, 2079)

Responder

"There are many numeral systemin the world .The recently used numerals Hindu-Arabic numeral system,Devenagari numeral system and Roman numeral system also there are the computer numeration system such as Binary, Quinary, Octal numeral system and so on are also used. The Nepalese Licchivi numeral system is developed around 400-500 AD in the Licchivi Kingdom. The Licchivian king used the Licchivi numeral in coin. The Amsuvarma coin is famous in the Licchician period. The effect of Licchivian numeral in the malla kingdom also. Mainly in the development of numeral system the Mathematicians Naya Raj panta, Chadrakala Devi Dhanajjaya, Laxmipati pandey and the 21st mathematicians Ram Man Shresth, Shantosh Man Maskey, Eka Ratna Acharya, Neelam Subedi etc. are studied and research about the numeral system in Nepal." (15th Baishak,2079)

Responder:C

"Number is the result of daily life activity on a society. Numbers and numerals are comes from the ancient human civilization and later its developed as the numeral system. Mathematical knowledge is directly related to the society and social culture. The general people doesn't know about the numeral system developed in Nepal and Nepalese society. They only know about the Devnagari and Hindu-Arabic numeral system. So,it should be provide about the indigenous mathematical knowledge and we should research and published our mathematicalknowledge. There are different -different symbols and languages to denote the numbers in different cast and culture. The evidence of Bahmi numerals in Ashoka Pillar of Lumbini Nepal and the Symbol of Ranjana numerals found in Bhaktpur Darbar Square area."(1st jesth,2079)