PRIMARY SCHOOL EDUCATION AND CHILDREN'S UNDERSTANDING OF SCIENCE CONCEPTS REGARDING MOON PHENOMENON IN THEIR CULTURAL CONTEXT

By

MASOOD NADEEM

Dr. Muhammad Ajmal
National Institute of Psychology
Centre of Excellence
Quaid-i-Azam University
Islamabad-Pakistan
2009

PRIMARY SCHOOL EDUCATION AND CHILDREN'S UNDERSTANDING OF SCIENCE CONCEPTS REGARDING MOON PHENOMENON IN THEIR CULTURAL CONTEXT

By

MASOOD NADEEM

A dissertation submitted to the

Dr. Muhammad Ajmal
National Institute of Psychology
Center of Excellence
Quaid-i-Azam University, Islamabad

In partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

IN

PSYCHOLOGY

2009

PRIMARY SCHOOL EDUCATION AND CHILDREN'S UNDERSTANDING OF SCIENCE CONCEPTS REGARDING MOON PHENOMENON IN THEIR CULTURAL CONTEXT

By

MASOOD NADEEM

Approved by

_____
Supervisor

_____
Director, NIP

_____
External Examiner

_____
External Examiner

Dedication

This thesis is dedicated to my wonderful parents, Prof. Muhammad Ayub-ul-Hassan and Akhtar Farzana, the two most special persons in my life. They not only gave me life, but also fill it with all the love and affection one can wish for. A special feeling of gratitude my loving parents, whose words of encouragement and push for tenacity ring in my ears. Who have raised me to be the person I am today. You have been with me every step of the way, through good times and bad. Thank you for all the unconditional love, guidance, and support that you have always given me, helping me to succeed and instilling in me the confidence that I am capable of doing anything I put my mind to. Thank you for everything. I love you!

I also dedicate this work to my wife Abida and my kids; Fasih, Dayan, and Zahra, who have supported me throughout the process. I will always appreciate all they have done; especially my wife who never left my side, she remained there for me throughout the entire doctorate program. You have a very special place in my heart and you deserve very special thanks. I dedicate my dissertation work to my brothers and sisters. Thank you for all of your love, support, and sacrifice throughout my life.

This thesis is dedicated to my teachers, who enabled me to differentiate between right and wrong and are always the source of enlightenment and courage. Who guided me and became the source of motivation to achieve the highest goals in my life and developed the ability to think critically and independently.

CERTIFICATE

Certified that PhD dissertation titled, **'Primary School Education and Children's Understanding of Science Concepts Regarding Moon Phenomenon in Their Cultural Context'** prepared by Mr. Masood Nadeem has been approved for submission to Quaid-i-Azam University, Islamabad.

(Dr. Muhammad Pervez)

Supervisor

CONTENTS

ACKNOWLEDGEMENTS

First and foremost I am thankful to my Allah, Who never left me alone despite all my shortcomings and Who bestowed me with determination to complete this research successfully. Without His bounteous blessings it was not possible to achieve this goal.

The work which resulted in this thesis would not have been possible without financial support. I highly appreciate the Higher Education Commission of Pakistan, for granting this support under the Indigenous PhD 5000 Program.

The role of an advisor as a mentor, providing guidance and support towards the completion of a thesis cannot be over-emphasized. Dr. Muhammad Pervez (Retired Professor & Director), from *Dr. Muhammad Ajmal*, National Institute of Psychology; Quaid-i-Azam University, Islamabad, played this role to its fullest. Very high regards to my supervisor, for not only inviting me to join and initiate the present work but also providing help and encouragement to conduct the study. His wisdom and guidance helped me in netting all the different stages into the completion of this work. Without his critical judgments and continued support from the early days of this research work to the present, it would not have been possible for me to complete this research successfully. I owe much more than I can ever hope to repay.

Many thanks are due to Dr. Robert Louisell (professor emeritus), from Saint Cloud State University, Minnesota; USA. He graciously allowed using the *Interview Schedule* developed by him and his colleagues. I can never forget his prompt replies of my emails, his help in searching and consulting the research articles, lending the important books, and his invaluable advices in shaping and conducting this dissertation.

Visiting a technologically advance country for research and academic purposes is a very unique and rich experience for an individual from a third world country. The credit goes to Dr. William Cobern, Director, Mallinson Institute of Science Education, Western Michigan University, Kalamazoo, USA, for creating a space for me to work as a visiting research scholar. I conducted several meetings with him and other colleagues regarding my research. I always came up with lot of suggestions and valuable feedback. My stay at WMU, helped me in collecting the research material, books, relevant literature etc. I will remain thankful to him for extending his cooperation and his kind hospitality. I am again thankful to HEC for awarding me International Research Support Initiative Program; under which I was able to make this visit possible.

I am thankful to Professor Dr. Anila Kamal, the Director of this institute for her continuous encouragements to complete the research work, and in tackling the technical and administrative procedures in a nice and professional ways.

The author cannot overstate his gratitude to Dr. Rubina Hanif, who was always there in the time of need. I am highly indebted for all her acts of kindness and friendly attitude. I say thank you very much for her support and help.

I am highly thankful to Dr. Jamil for his valuable inputs and technical support in preparing the presentations and manuscript.

I would also express my thanks to Mrs. Tehmina Saqib, for her help and guidance during the entire period of research. She helped in the process of write up and proof reading of the final draft.

The Head Masters/Principals and the staff of the schools deserve grateful acknowledgement for allowing me to conduct the study in their schools. The lively and innocent children, who were interviewed, deserve a note of thanks for giving me

an opportunity to explore their cognitive depth and conceptual understanding regarding the phenomena under this study.

I cannot overstate my gratitude to all of my friends who were always there in the time of need. I am highly thankful to Muhammad Rafiq Mufti, Ali Arshad, Dr. Fayaz, Dr. Rana Ramazan, Athar, Muneeb, Nadeem Khakwani, Remona Salik, and S. Hameed Qaiser, etc. Since it is not possible to list all the names, I offer the following in the hope that underlying sentiments are very well understood to those, whose names are not mentioned. Thanks every one.

I am thankful to the library, administration, and computer lab officials for their unending help and assistance. Special thanks are due to Mr. Mohsin Sajjad, Qayoom, Khalid, Hanif, Arshad, Nazir (late), Haji Aslam, Tahir, Hayder, and Usman etc.

I am deeply grateful to my mother and father, who are my first teachers and the source of inspiration and guidance forever. What so ever I achieved in my life, is undoubtedly due to their prayers, which they always keep on doing for me. Without their boost, help, and cooperation, I could never have achieved this success. I am also thankful to my brothers and sisters (especially my elder brother), who is very kind to me in all my difficulties and crises, I met in my life.

Above all, my special feelings of love are due to my wife and kids; Fasih, Dayan, and Zahra. I express my thanks to them, who suffered the most and I could not pay much attention many times during my laborious work. God bless them all.

Masood Nadeem

ABSTRACT

The present research was conducted to explore the understanding of science concepts in the primary school children. The study mainly focused upon the cultural context in the development of concepts. The main objective of this study was to focus its data sources and sample target on primary school education and children studying in primary classes. Two studies were carried out in different phases to explore the children's understanding about the natural phenomena of the moon. For the purpose of present research, an in-depth interview protocol (Kazemek, Louisell, & Wellik, 2007) was translated into Urdu and used for data collection. In developing the interview schedule, the researchers have used Piagetian (1975) traditions based on his questions about the origins of the moon. The process of translation was completed in the initial phase of the study. For translation, committee approach was adopted. Study I was completed in three phases having different steps. In phase 1, try out study was carried out on three children, in order to pre-test the interview schedule translated in the initial phase of the study to check the suitability of the instrument and to identify different themes of the children's moon concept for future study. The results revealed that children achieved their knowledge about moon through different sources. The important source was the relevant culture in which they lived. Strong cultural and social factors influenced the children's conception of the moon. Such concepts may have developed through their interactions with the world, including parents, teachers, and artifacts. Results showed that the respective cultural patterns including the religious rituals played a significant role in the understanding of the natural phenomena of moon. This influence can be positive and negative in terms of learning science concepts in schools, from books, and through parents or elders, etc. The ideas that children developed may or may not be consistent with the social or

cultural environment. Phase 2 of the study was completed in four different steps. In step I, pilot study was conducted to interview with the children; step II comprised of interviews with parents and teachers; step III consisted of observation of the T.V programs; and the main objective of step IV was to analyze the contents of the interview schedule, to develop the coding schemes for the analysis and interpretation for further main study, and checking out the appropriateness of the categories of responses as results of the questions asked to the children. So that to figure out any flaws that may interfere in the findings while conducting main study. Some contrasting results have been pointed out in the step II and III of the study which proved not to be much helpful in the main study. Phase 3 had two steps. In step I, content analyses of the two Urdu national dailies was completed. The results showed a very weak link between actual understanding of science concepts and printed science knowledge in the newspapers. Step II had detailed account of multiple analyses of textbooks of class I, III, and V. The results revealed that implicit and explicit science concepts instantiated in the textbooks failed to be helpful in the better understanding of the science concepts of the children. The presented concepts have been discussed in terms of space, volume, illustrations, and pictures in different forms and modalities in the textbooks. Study 2 of the present research was the main study that was carried out on a relatively larger sample to have more authenticity and generalizability of the research. The participants (sample) comprised of 12 boys and 12 girls equally from the different primary schools situated in Islamabad. These schools ranged from main metropolitan areas to the suburbs of the city. All the children belonged to the class I, III, and V. The main study based on the interviews with the children. Analysis procedure was same as adopted in the pilot study. Results showed somewhat similar trends of misconceptions about the natural phenomena of

moon among the children. The results indicated that the science concepts are poorly understood and acquired by the children. The results also supported the influence of cultural artifacts and psychological tools in the understanding of concepts. However, the findings showed that social and cultural institutions including school, teachers, parents, media, textbooks, and newspapers, in the transmitting and transferring of the knowledge are contributing at a minimal level in typical Pakistani cultural context. Psychological and educational implications, future directions of the research, and limitations of the study have been discussed.

LIST OF TABLES

LIST OF FIGURES

LIST OF ANNEXURES

A Point to Ponder

"*Those were the days of August 2004. I was in my study room, reading newspaper. My elder son aged 18 months was playing around. August is the month of celebrating the independence of Pakistan. Suddenly, I noticed that he was trying to ask a question from his mother. I moved forward and saw him holding a small Pakistani flag in his hands. The question was "what is this… here….mama?" He was pointing towards the star and moon printed on that flag. Perhaps that was his ability to explore and understand the things and phenomenon around, also that was the start of learning, acquisition, and understanding of the 'Concepts'. After that, I went into deep thought and started thinking to know and see how the individual's interactions with the material world contribute in the development of the concepts, and what are the possible sources of understanding those concepts?"*

This simple but important event paved the basis for this research.

Masood Nadeem

Chapter-I

INTRODUCTION

Science and technology has become an integral part of the modern global culture and is the major driving force for economic growth and development. The power of science and technology has transformed the world and has had impact on almost every sphere of man's individual and collective activities: economic, political, cultural, social, military, or educational etc.

This scientific progress has received impetus from various sources. One major source is the education being imparted to the children of any nation. By giving proper education to the children the future of the nation can be saved.

In Pakistan a lot of emphasis is being laid upon education, and efforts are being made to improve the quality of education. Still this country is unable to create an environment which triggers off a scientific and technological revolution whereby a broad-based, self-sustained scientific and technological structure is established. Although in the past few years some steps have been taken to improve the quality and standard of the higher education in Pakistan. However, the educational system particularly at the lower level lacks many things. This is debated in the psychological, academic, and educational circles that education on the whole and specifically science education has failed to play its required role in the development of scientific concepts in students and promoting scientific thinking in the Pakistani society. The problem can be traced right from the beginning of child's early classes to higher education.

Officially *Primary School* is the starting point of formal education of a child in Pakistan. This is believed among the researchers in the country that primary school

education is one of the neglected areas of research in Pakistan. This is also believed that within the total system of education, science education is perhaps even more ignored part of research. Considering this fact, the present study signifies to see understanding of science concepts at primary level from a cultural context. It is a common observation that existing educational system of the country is geared to the suppression of creativity. It revolves around the medieval system of learning by rote. It is unable to create a conducive and supportive culture of science and scientific thinking. As a matter of fact, the education has never been considered a priority of the nation by successive political and non political governments. This negligence has seriously undermined the entire educational system.

It is believed to know about the history, if somebody wants to have a better insight of a problem. So, by looking into the history and culture of the nation will lead to know why it was not able to get the highest standards in the education sector. Furthermore, what sort of crises and difficulties this country had been facing throughout different stages of its history?

Historical Underpinnings and Cultural Orientations of Pakistan

A brief history. Pakistan emerged on the map of the world on 14th August, 1947 when British India was partitioned into two sovereign states, Pakistan and India. Pakistan comprised five provinces and some princely states of British India: East Bengal, Punjab, Sind, North West Frontier Province (NWFP), and Baluchistan. East Bengal is no more the part of Pakistan; it has become an independent country: Bangladesh.

The creation of Pakistan was the result of the desire of the Muslims of the sub-continent to develop individual and collective life according to the Islamic values of liberty, equality, and fraternity. The Muslims of the Indian sub-continent also aspired to develop and maintain democracy, social justice, equality of man, and to establish such an educational system that is based on the golden principles of Islam.

Religion. The country's official name is *Islamic Republic* of Pakistan. The basis of the creation of the country is associated with the ideology of Islam. Islam has been the main source of guidance right from the routine lives of the individuals and social level to policy implementation at government level.

According to the teachings of Islam there is no concept of separation of church and state in Pakistan. Educational aims, policies, and curricula will be derived from the Islamic teachings.

The country witnessed political instability for more than forty out of sixty years of its independence; this great country has been in a state of emergencies and turmoil since its birth. This is why our policy makers and leader ship has not been able to pay full attention to other human resource sectors, including education.

However, some efforts were made to improve the standards of education, individually and collectively. For better understanding of the education system of Pakistan, we must go through and find its roots in the educational history of the sub-content.

Muslim awakening in the sub-continent. The chief causes of the down fall of the Mughal Empire were the intellectual and moral decline of the Muslims. However, some great people felt the responsibility and tried to reform the society.

Sir Syed Ahmad Khan was the founder of the Aligarh College. Basically a reformer, Sir Syed utilized education as an 'instrument' for reforming his nation, thus becoming pioneer 'instrumentalist' or 'pragmatist' in the field of education in India. He believed in the dynamic and progressive functions of education.

Revolutionary ideas were strongly opposed by the reactionary people. Shible Naumani sponsored the idea of integrating the oriental studies with the modern ones. With this purpose in mind, he established an institution of learning called 'Darul-Uloom Nadvatul-Ulema', at Lucknow in 1898. But this oriental type of education could not appeal to the people to a great extent.

Moulana Muhammad Ali founded Jamia Millia Islamia in Aligarh, in 1920. This school flourished under the patronage of Hakim Ajmal Khan, Dr. Ansari, and Dr. Zakir Hussain. The chief characteristics of Jamia Millia were that the vocational subjects were integrated with the usual unilateral academic type of education.

Sir Muhammad Iqbal was a great poet and thinker of the Indo-Pakistan sub-continent. He was not an educationist in the limited sense of the word, but Iqbal's educational thought is identical with the philosophy of education. Iqbal aims for education as a preparation for life and the development of character and personality of the learner. He advocates learning by 'doing' and 'active participation' of the students in the development of lessons.

Iqbal's philosophic and poetic contributions had great influences upon the Muslims of the India. His political wisdom dreamed for a separate nation and country

in the Indian sub-continent, which eventually laid the basis for the creation of a new homeland ‘Pakistan’.

Psychologists believe that particular events or important landmarks of history leave profound effects on the persons of the society individually as well as collectively. Such events contribute in the shaping and formation of different social and psychological characteristics of the society. ‘Culture’ is one of the important factors which are affected by certain events in the history of any nation. Such cultural factors have great consequences in the psychological development of the individuals and particularly the children. So, it is important to know about the ‘culture of Pakistan’ to get a better insight, especially in this technologically modern world, to understand how the advancements or standstills have affected the people. The above discussed political, educational, religious, and military developments have shaped the existing culture of Pakistan. Let us see what are the distinguishing features of Pakistani culture?

Culture of Pakistan

Setting aside the typical way of indulging into philosophical and academic debate of defining and describing the nature and distinctive features of ‘culture’ in terms of psychological, sociological, and anthropological theories, it seems better to view the culture of Pakistan in the light of brief history of Pakistan discussed in the previous sections of this chapter.

If analyzed carefully the history of Pakistan, it can be concluded that cultural history of Pakistan gets the strengths from three main possibilities; (1) Historical and racial (2) Religious (3) Political and economic.

Ullah (1972) has stated a detailed account on these three sources. If one wants to view the Pakistani culture in respect of race and history only, then it must consider the Indian history starting from 2000 B.C. No doubt earlier warriors and invaders mixed with the local population of India. As a result, a new culture evolved with the mixture of foreign and native elements. However, this was not the case with the Muslims. The Muslim rule was an exception to this regard. The Muslim culture as a whole remained distinct and maintained its individuality in a quite contrary and rich local culture of India. So, this is assumed that the prevailing Pakistani culture cannot be rooted back to ancient racial and cultural history of India wholly.

Assuming that the present Pakistani culture deriving its strength only from religion, that means Islam, should embody the cultural characteristics of the typical Arabic—Muslim ways of life. This is true that Islam is the main source of strength in shaping the cultural patterns of the Muslims of India. However, Pakistanis have also developed their own peculiar cultural patterns, which is an indication that religion is not the only deriving force in forming the cultural patterns.

The third identified source of strength is that, culture is the direct result of the specific socio-economic and politically motivated needs. This is assumed that in order to survive with a very strong and old culture of India, the Muslims of India had to evolve a Muslim specific culture that would not alienate them socially, economically, and politically. The freedom struggle of the Muslims of India was a true reflection of such needs.

In the light of the above discussed assumptions, this can be concluded that the present Pakistani culture is the blend of all these three possibilities, representing a rich diversity, with no single visible pattern. Therefore, it is difficult to talk about a single Pakistani or even an Islamic culture.

The development and progress of the modern and civilized nations depends on how the nations value and conceive education as a collective conscious effort. So, this is important to understand how the concept of education is taken as a policy and perceived as a philosophy in the contemporary world.

Avoiding the traditional ways of embarking upon the 'definitions' of education, in the coming sections a description of the concept of education will be elucidated and its significance will be highlighted in the process of development and progress of the nations.

Concept of Education

The term 'education' has been conceptualized differently in different periods of history and regions. To understand the modern concept of education, one should know what the old civilizations thought about it.

Starting from the history of two ancient civilizations Egyptian and Samarian periods, the ancient Egyptian people had created a rich literature which included prayers and hymns to the gods, myths, folk tales, and epics. Two books are found in old history of Egypt; 'Book of Dead', its main teachings were to avoid sinful conduct, ranging from murder and fraud to offenses like idleness and gossips, Smith (as cited in Adeeb, 1996). Adeeb (1996) has depicted a good account on the concept of

education in his book '*The Concept of Higher Education: Comparative Study of Developed and Developing Countries'*. He has mentioned a book named as 'The Gilgamesh Epic' which was written in the Samarian region of Babylonia. This book preached that life is short and whatever we do there is no hope of immortality.

Adeeb further pointed out that in Persia Prophet Zoroaster preached about good and evil forces. In Palestine the Hebrew and Moses identified brotherhood, truth, and justice as the supreme ideals and developed doctrines and ethical teachings.

Taoism and Confucianism were the two main religion which established great civilizations in the East, and Hinduism in the Indian Subcontinent and Shintoism and Buddhism in Japan. Hinduism provided many ideas for man's emancipation, the ultimate goal of life, and the relation between Guru (teacher) and Chaela (student) (Adeeb, 1996).

The known history of Western education goes back to the Greek era, where education was idealistic in nature. Plato, a Greek philosopher, described different levels of education and for producing intellectual citizens, skilled military men and governing philosophers. He offered little effort for the industrial class, because, there was hardly an organized labor class during that time. As a result of industrial and scientific development the demands of society became quite different by the 18th century. That resulted in the disapproval of 'idealistic' theory of Plato. The ideas of Locke got popularity in the West. He introduced the theory of knowledge which was derived from those things perceived through the senses. His approach on education initiated the modern empirical turn in education (Adeeb, 1996).

In 18th century, a shift came in education by the ideas of Rousseau. He viewed the process of education as an integral part of social reform. Rousseau advocated that

society should be associated with nature and education should develop a natural response to real life.

During the 18th and 19th century Herbert and Spencer supported the idea of individual learning. During the same period Hegel regarded education as the struggle of higher liberation. Froebel supported the idealistic approach.

Theories of Idealism and Individualism in education remained popular until the first half of the 19th century. In the second half of the century the movement converted into socio-economic theory of Communism with the notions of Marx and Engels.

Meanwhile in America a progressive approach got the popularity. Dewey considered progressivism as the base for radical reformation of society. According to him education should be viewed in the context of society having permanent interaction between man and the environment. The main aim of Dewey's philosophy of education was that it should reflect the main trends of contemporary thought and incorporate them with the techniques that have so significantly contributed to modern industrial and social progress. Dewey saw education as a process of living and not as a preparation for future living (Leonard, 1970).

This brief historical background of the developed nations signifies that the concept of education varies from nation to nation and from culture to culture because every conception of education is the product of some ideal of life and every ideal of life has its own conception of education. Education which does not take into account the cultural and regional realities will either fail to deliver the goods and positive or do harm instead of facilitating development. The genesis of development must be indigenous to the cultural soil from which it springs, and cannot be imported or

exported like rice and wheat. No nation can progress if it is not free to develop according to its own ideals and genius. The education which a country imparts to its generations must be in harmony with the goals and objectives that are to be achieved. A destination in the East will never be arrived at if one faces the West. Perhaps, this is the dilemma we are facing in Pakistan.

After having the background knowledge about the history and culture of Pakistan, now it seems important to look into deeply the actual state and status of education in the country. Therefore, further discussion will be focused on the overall state of affairs in the educational sector with special reference to primary school education.

Education in Pakistan

After the independence, there was a need for introducing a new system of education with the right aims, and objectives and which could meet the individual and collective needs and aspirations of the people. The early political leadership was fully aware of these educational needs, despite all the challenges, that a new nation was facing. New educational policies were drawn, but the sacred aims and objectives could not be realized even after many decades of independence.

The Issues of Literacy, Enrollment, and Funding

At the time of independence in 1947, Pakistan had a poorly educated Population and few schools and universities. West Pakistan had only one institution

of higher education, the University of the Punjab. East Pakistan had the University of Dhaka.

Although the education system has expanded greatly since 1947, however, still the literacy rate is low. According to Survey 2004-05, the literacy rate of population 10 years and above was 53%, showing an annual growth ratio of 1.5% since 1998 Census. As such the estimated literacy rate comes to 56% in 2007 (Ministry of Education, 2009).

Comparison of data for men and women reveals significant disparity in educational attainment. There is a wide gap between the literacy rate in terms of gender. Men literacy is 63% comparing with the women, which is 36% (UNICEF, 2009).

Pakistan has never had a systematic, nationally coordinated effort to improve the enrollment in the schools. According to Survey 2004-05, the Gross Enrollment Rate (GER) was 86% at Primary level; 46% at Middle level; 44% at Secondary level; and Post-Secondary 4.6% (World Bank, 2005).

Relatively limited resources have been allocated to education. Pakistan stands among those nations, who spent a critical low on the education sector. Over the decades, amazingly, a significant drop in the proportion of GDP allocation to education is witnessed. In 1990, Pakistan was only behind India and Maldives in terms of allocating resources to 'Education For All' (EFA) movement as percent of GDP per capita (Pakistan 7.4%; India, 12.2%; Maldives, 10.0%). However, it lagged behind every country in South Asian region by the year 2000, spending just 7.8% (Husain, Qasim, & Sheikh, 2003). By the beginning of the new century, the proportion of GDP spent on education had not risen as expected, settling at 1.7

percent in 2001-02 compared to 2.1 percent in 1991-92. Spending on primary education share of GDP was also at low 0.8% of GDP in 2000-01 (Boissiere, Baig, Modi, & Zafar, 2007).

The total public sector spending on education (by federal, provincial, and district government) comes to 12% of federal budget 2005-06, which is the 2.21% of GDP during the year 2005-06 (Ministry of Education, 2009).

If we aspire to be a developed and prosperous nation, we will have to allocate the maximum funds at various levels in education sector.

System of Education

The education system of Pakistan can be divided into five different levels: Primary or Elementary Education (Pre-primary to 5th class); Middle Education (6-8 class); Secondary Education (9-10 class); Higher Secondary or Intermediate Education (10-12 class); Higher or Degree Education (class 12 and onward).

Beside this regular and traditional system of education, there are other systems running in the country, which are called: Technical and Vocational Education and Religious Education (Maddrassahs).

Hence, the focus of this study is primary or elementary education. Therefore, upcoming discussion will be related to primary school education in Pakistan.

Schooling in Pakistan

Pakistan at the time of independence had a poorly educated population and few schools. It inherited an educational system installed a hundred years earlier by colonial rulers replacing the indigenous Muslim system which had served the country for nearly eight hundred years. Still Pakistan is having more or less the same educational system.

Although it is thought that the education system has expanded greatly, with the exception of few elite institutions since the independence, but quality remained a crucial concern of educators even in the 21st century.

In rural schools single teacher and two-teacher schools are common where the number of children may be very small but schools in big town and cities are generally overcrowded and a large number of them are run on the double shift system.

Individual schools may have more than one educational level. A primary school will have only class 1 to 5; a middle school may have classes 1 to 8 or only class 6 to 8. A secondary (High) school may have classes 6 to 10 or only classes 9 to 10. Some high schools (Higher Secondary Schools) may have the intermediate classes 11 to 12.

A Typical Pakistani Primary School

A child who reaches the age of five or above is supposed to get admission in class 1 in a primary school. There are separate schools for boys and girls all over the

country, however in some localities there is coeducation. But still the staff is not female and male together.

Compulsory subjects at the primary level, class 1 through 5, include Urdu, Islamiat, Social Studies, Mathematics, and Science. Curriculum is standardized throughout the country although some local variations and changes are permissible according to the typical local and cultural demands, if the school has resources.

Availability of the material and quality of infrastructure and development in government schools is far behind to meet the minimum standards. Andrabi, Das, and Khwaja (2002) quoted comparisons to school characteristics among Public and Private schools with regard to Mean Student-Teacher ratio (Public, 42.7; Private, 24.8), percent of Schools having Toilet Facility (Public, 48%; Private, 84%), Classrooms with Desks in a School (Public, 40%; Private, 80%), and Classrooms that are Unusable in a School (Public, 24%; Private, 12%).

According to the Human Development in South Asia's 1998 report, 70 per cent of the schools in Pakistan have no toilets, 68 percent no drinking water, 92 percent no playgrounds, 60 per cent no boundary walls and 16 percent having without a building.

A delegation from the UK to Pakistan has also noted a lack of desks, books, blackboards, electricity, doors, and windows, not to mention the problem of overcrowded classrooms. And the phenomena of "ghost schools", institutions which receive government grants but do not exist, are now common knowledge.

Types of schools. Almost in all the big cities of Pakistan, there are three types of schools imparting education, government ordinary schools (Federal and Provincial levels); Model/Pilot/Comprehensive schools, also government funded and private

Urdu/English-Medium schools. The government encourages the private sector to expand the primary education and to share the burden on public exchequer. Even then, unfortunately, Pakistan is facing the problems of high dropout and low participation rates at primary levels. This ratio of dropout and enrollment is among higher among the girls as compared to the boys (Pervez, 1992). This trend is more prevalent in the rural areas. Successive governments have been trying to achieve the goals of free, compulsory, and universal primary education. That is still a dream to come true.

Primary Education in Pakistan

For any nation primary education should be the foundation of the entire pyramid of the educational system. This base has not yet been broadened and stabilized in Pakistan. The problems of high drop outs and low rate of participation are still being faced by the successive governments.

A case study by Independent Evaluation Group (2007), which is an independent unit of World Bank, provided some good chronological benchmarks with regard to Primary Education in Pakistan, in respect to much historical and political-economic landmarks such as independence (1947), the Education for All (EFA) conference (1990, in Jomtien, Thailand), and the advent of the military regime in Pakistan under General Musharaf (1999-2008).

The constitution of 1973 conceived a free and compulsory primary education for all children, but this dream yet has to be turned into reality. The entire pyramid of

education has a disproportionate growth. The base of primary education is narrow, whereas, the higher education is relatively broadened.

The history of primary education in Pakistan since independence has been a struggle to achieve quality universal primary education (UPE), and to do so amid resource constraints and governance and management problems. The combined effect of these three problems has led to serious inefficiency, and at time outright corruption in the delivery of quality education services, in addition rapid population growth of about 3 percent throughout most of the post-independence period has made it even more difficult to raise enrollment rates. Only in the late 1990s has the population growth rate slowed to just above 2 percent. Demand side factors have also come into play in Pakistan's UPE efforts, such as traditional attitudes limiting girls' participation in school. As a consequence of these constraints, Pakistan is still far from UPE. However, the gross enrollment rate began at 15.8 percent (25.7 percent for boys and 4.4 percent for girls) just after independence (1949-50), and it rose to 84.3 percent (90. 7 percent for boys and 77.7 percent for girls) in 2001. It is clear that Pakistan still has to struggle to get a significant progress in attaining the UPE (Husain, Qasim, & Sheikh, 2003).

Primary school education: Structure and organization. According to the constitutional and administrative structure of Pakistan, education is shared between the federal as well as provincial governments. The organization of the primary school can be divided into three levels of management; top (Federal Ministry, Provincial Educational Departments, Interprovincial Committee of Education Ministers, and Secretaries), middle (Provincial Directorates, Divisional Directorates, and District

Education Offices), and bottom (Principals/ Headmasters, Teachers, Clerks, and other supporting staff) management. Federal government provides the basic development and coordination of national policy, plans, and program in education, development of curriculum and textbooks, development of instructional technology, promotion and coordination of educational research. Whereas middle and bottom level management implements such policies, plans, and orders passed on to them. There is no separate organizational or administrative system for primary education. The capital to meet the development expenditure in provinces is given by the federal government while the recurring expenditure to meet the salaries and other supplies is provided by the provincial governments (Saleem, 1991).

Among all the educational levels, primary education is in the most difficult state, due to the wide lapses and gaps in the implementation of the policies. Supervision and feed back is too sluggish through various administrative channels from the federal government to the local grass root level. Supervision of primary education is controlled by the provincial governments through the delegation of powers to district levels. In Pakistan primary and secondary education is administered together. This has overemphasized the grades 6 to 10 and a criminal neglect of grades 1 to 5. Presumably, the mangers think that upper grades need more importance.

According to the new devolution set up of local governments introduced by Musharaf regime, the schools from grades 1 to 10 are controlled by the Executive District Officer for Education (EDO Education). They are assisted by the number of Assistant Executive Officers for Education (AEO Education). A district is a basic unit of administration in the country, which normally comprises the population of around two million people. The EDOs work under the district management, headed by a

politically elected district chief called *Nazim.* Education sector is still a provincial and federal subject. Therefore, policy decision, attainment of important aims and objectives regarding primary school curricula is the responsibility of curriculum wing of the Federal Ministry of Education. Improvements in textbooks and their review, teacher training programs and examination reforms is also included in its functions. Each province has a separate Bureau of Curriculum Development and Extension Center to implement the curricula in the light of national policy.

The whole organization of primary schools is more like a structural bureaucracy consisting of hierarchical positions authority relations, specialized functions, rules and regulations that govern the institutional, managerial and technical tasks and processes of the organization. According to Saleem (1991) there are no standard criteria exists for evaluating the efficiency of the organization as well as the teachers.

There is a lack of coordination between the policy and practice regarding educational planning in Pakistan. Planning and decisions are made at higher levels in the capital. The requirements and feedback sent from the actual situation is seldom fulfilled due to typical red tapism.

The teachers are appointed by the EDOs without any standardized selection procedure. The jobs are announced in the newspapers, the candidates apply for the required posts. Hundreds of applicants apply for one post. The merit is determined by the obtained marks of the candidates in previous educational certificates along with so called performance in an oral interview. The selection is done on the basis of cumulative scores on these merit criteria. Officially primary school teacher has the qualification of at least matriculation (ten years of school education) with additional

nine months duration '*Primary Teaching Certificate*' (PTC). Despite this course of professional training, it is a matter of big question to what extent he or she actually learns. There is a wide gap in actual theory and practice, because this is a basic requirement for getting the job and it has nothing to do with the teacher's actual teaching ability and competence. Some time merit is neglected and political pressure and nepotism overcome in the recruitment of the teachers. Even there are cases where some teachers are without training and above mentioned minimum criteria for selection.

The profile of a teacher. The basic qualification for the primary school teacher is Matriculation, with one year teaching training course. In most of the cases, schools in rural areas, there is no departmentalization. In such situations, apart from the classes, schools are self-regulated and run by the same single teacher, working as subject teacher, class teacher, and also doing the job of principal/headmaster. Contrary to that, where the staff is more than two teachers, the senior teacher or headmaster, is in-charge of the school affairs. He is also the in-charge of the 5th grade class and may teach every subject to his class. If the strength of the teachers allows, then each class may have a class teacher, who has the responsibility of teaching, administration and assessment of the students. In big cities and urban areas, where the enrollment of the students is high and also the strength of the teachers is also sufficient, there can be departmentalization. These types of schools may have separate teachers for each subject.

Becoming a primary school teacher is considered to be a socially and economically low status. This causes the lack of teacher motivation. This problem has and continues to lead to the erosion of standards in the nation's schools.

In practical terms, a teacher's poor motivation translates into absenteeism, indifferent classroom practices and teachers leaving the profession. This high ratio of leaving out the profession is especially damaging for the whole system because the government's investment in teacher training is lost and new expenses are incurred in training new teachers. There are several reasons for this lack of motivation. For example, inadequate salary structure, low social status as being a teacher, poor working conditions, little opportunity for career development etc.

Despite this reality, especially in rural areas of the country, the teacher has an important position among the masses. He is the torchbearer of the educational heritage and tradition. Authoritarian image of a teacher is one of the traditions that have been transferred to him during his education and training. That means he has to bestow his '*knowledge*' upon his students. A child is considered to be an '*empty stuff*' in traditional educational methodology through which he has been trained and educated. And this empty stuff has to be filled with the knowledge of the teacher. A child is always on the recipient end. So, he should absorb the things by rote memorization. The child's ability to construct knowledge is totally denied and discouraged at every stage of the educational process. The written material in textbooks is the only authentic knowledge that has to be memorized and recalled, which is eventually reproduced after a year's study in the annual examinations. This is the sole criteria of successfully passing on the knowledge. This chain of transferring

and passing on knowledge is hard to break by introducing any change at some levels of the system (Pervez, 1992).

Curriculum and textbooks. According to Fraser (as cited in Levin, & Lockheed, 1983) international summaries of research demonstrate that students learn the content of curriculum they are taught. It has been discussed in detail in earlier sections of this study about the curriculum, that how the curriculum is developed and implemented throughout in the country. This is a difficult question to answer for any one, what is really a curriculum? As it is mentioned earlier that text-book are published and curriculum is developed and prescribed by the federal government. This is obligatory for all provincial governments to implement and follow that published curriculum by all the schools of the country. The teachers will be trained in accordance with the implementation of that curriculum. The whole training courses revolve around implementing the contents and methods of the curriculum. However, the training methods, programs, materials, and manuals are also debatable regarding their effectiveness. As it was discussed earlier that memorizing the contents of the curriculum remains the only purpose to maintain, attain, and to achieve the educational standards. This lack of integration at conceptual level may be seriously undermining the learning process. That results in the failure of cognitive levels; firstly, there is no help available from the teacher to make the content cognitively meaningful. Secondly, the cognitive demand level of the content may not match to the children's cognitive ability (Pervez, 1992).

Textbooks also suffer from factual inaccuracies, inappropriate illustrations and poor choice of text language and script. Teachers in Pakistan were surveyed for their

opinions regarding textbooks reported that the books were overly difficult for their students; putting too much burden on children and making them feel uneasy. In particular, because the children could not read fluently the Arabic style Nasakh script used in the textbooks, the children failed their examinations unless the teachers read the textbooks for them and summarize and shorten their lessons (Government of Pakistan, 1983).

Teaching styles and methodologies. This is witnessed that teaching methods implied and used in Pakistan at primary schools, only promote memorization of the contents of the textbooks. Writing is done by copying the characters, digits, and words. Not only the mathematical and other scientific concepts, but the concepts related to social studies, history, literature, and humanities are also forced to memorize. The teaching method supports the reproduction of the memorized and crammed material. The examination system backs this memorization of the literal contents of the textbooks.

Despite the claims of introducing and having a teaching method based on conceptual learning, the prevailing methods for instructions and teaching leave no room for inquiry method and independent exploration at the end of the children. This is how a vicious cycle is going on at each level of educational processes, and thus causing a serious damage to the whole education system (Pervez, 1992).

Physical conditions of the schools. Leaving apart some privileged schools in some metropolitan cities, generally the physical conditions of the primary schools is very alarming. School buildings are not appropriate for the teaching. Most of the time,

the schools have less classrooms as per requirement of the classes. At times there is no electricity or proper ventilation in the classrooms. Often the children are taught in the open air without shelter during rains or in extreme weathers. In the majority schools, appropriate furniture is not available. So, the children have to sit on the floor, even some times without mats. Mostly, the walls of the classrooms are without whitewash. One can hardly see the drawings and charts in the classrooms. Regarding the equipment, only a black board and chalk is considered to be available in the schools by the administration. However, the children should have text-books and some paper pencils to read and write. In earlier classes, a wooden board (*takhti*), slate, and a copy is used for writing (Pervez, 1992).

Overcrowding is the common phenomena in the urban area schools. Sometimes, nearly hundred children are admitted in one class. This disturbs the student teacher ratio. That eventually affects the efficiency of the teacher.

A larger distance from home to the school is another problem, especially in rural areas. The children in early classes have to struggle to reach in the schools in extreme weathers, as no facility of transportation is available by the government.

Condition of Science Education at Primary Level in Pakistan

In Pakistan, as it has been discussed earlier, the quality of primary education has a declining trend. It is realized that the state of science education at primary is generally poor; it has reached a critical low level of quality, and needs to be improved urgently. There is an acute shortage of teachers, laboratories are poor and ill-equipped, almost nonexistent, and curriculum has little relevance to the present day

needs. The textbooks are also sub-standard and finally, education system promotes rote learning and gives little emphasis to understanding and to develop thinking (Memon, 2007).

SEPG, stands for Science Education in Pakistan Group. This group is working for bridging the gap in standards between urban and rural education in Pakistan. The group believes that there is a disparity in education between the rural and urban areas of Pakistan. They believe that there is an acute shortage of good science teachers and lack of well equipped science laboratories (Science Education in Pakistan, n.d).

In our education system, particularly at primary levels, we can see a complete absence of development of scientific thinking. Teaching and learning processes are unable to develop the conceptual clarity of the phenomena, particularly science concepts. Teaching science in the primary school should be a challenging task. It is at this stage that children can begin to make the move from everyday to more scientific ways of thinking. Teaching and Learning at this stage is closely linked to social-cultural events, exploring phenomena and language from the everyday world and teachers have to continually move between physical phenomena and different sets of ideas associated with them.

Understanding and development of science knowledge as a social and cultural activity is not new to researchers, scientists, and teachers by now. Longino (as cited in Ebenezer & Connor 1998) proposed that the "primary method of objectifying knowledge must be processes of interpersonal negotiations and social consensus" (p.11). That means scientific activity and understanding of knowledge takes place in a social milieu. Human values, beliefs, and commitments are the social constituents of the science which are shaped up at different levels by interacting with the human

beings. Therefore, science should also be seen in and worked out in a social context. The sociological and anthropological studies reiterate that scientific knowledge resides in social practice rather than rational, individualistic mind operating apart from the world. So, there is a clear link between culture, science, and education.

Culture, Science, and Education

Taking the cultural and social perspective in relation to science education, means to view science, science education, and research on science education as human social activities conducted within institutional and cultural frameworks. This proposes that interpersonal social interaction, whether collaboration in a laboratory or dialogue in a classroom is only the smallest scale of the social activity, and such cooperative human activity is only possible because we all grow up and live within larger-scale social organizations, or institutions: family, school, mosque, community center, research lab, university, city, state, and even global economy. Our lives within these institutions and their associated communities give us tools for making sense of world, and to those around us: languages, pictorial conventions, belief systems, value systems etc. Collectively such tools for living---our social semiotic resource systems and our socially meaningful ways of using them---constitute the culture of a community (Lemke, 2001). Since 1960s, social and cultural perspectives on science and science education can be traced back from the developments in the social and human sciences.

In science education the role of culture, place, and personal experience is important in the professional development. This has been identified by Chinn (2007)

in his study. Implication of the study was the development of a framework for professional development able to shift science instruction toward meaningful, cultural, place, and problem-based learning relevant to environmental literacy and sustainability. This is important to know how this role of culture, society and individuals are playing in contemporary Pakistani society.

Involvement of Pakistani Society and Community in Primary School Education

Education is one of the most important sectors for the attainments of the cultural, political, social and economic aspirations through the discovery and encouragement of understanding of complex issues of children. While describing the political and administrative set-up mentioned in the previous sections, it does not seem to have any role for participation of the masses in the primary school education.

This dilemma can be traced back to the colonial period, among all other government functionaries; school was also associated with the *government* (skeptical connotation for the foreign rulers). That was due to one of the reasons of lacking in political participation of the masses. This legacy continued even after the creation of Pakistan. Somehow or the other, masses remained aloof from whatsoever was being done by the government. Perhaps this sense of alienation is the counter product of successive undemocratic governments for nearly about forty out of sixty years of independence. This attitude trickles down even to the basic unit of family; parents especially in the rural and less developed areas of big cities seem to be less motivated in sending their children to schools. This lack of motivation is perhaps due to social and economic factors. Therefore, parents cannot pay full attention to their children in

their educational processes and virtually a reasonably good majority of the children drop out from the schools. Hence, this has been a dream yet to make primary education compulsory and universal since long. There seems to be no real integration between the matters of schools and government. Rather this is quite contrary in a sense, because government controls the financial matters, and policy aspects. Whereas, there is no effective mechanism to monitor what really happens in the schools and to assess the class room processes. This weak link has made the role of teacher an authority and all in all. There is no check on a teacher, what he is really doing in the school. The community and governments are concerned only with the availability of the building for the school, salary for the teacher and in some cases furniture and equipments. As a result very comprehensive schemes of curriculum development, teacher training, audio-visual aids for the schools etc, end in the failure of the projects and policies. It seems that no one is interested in knowing what is really going on in the school and what is happening with the children. The parents feel that they have performed their duty by just sending their children into the school.

After having a detailed account of conditions of education in Pakistan, it seems important to know about those factors which are helpful in making sense of the child in the understanding and comprehension of knowledge. In education, concepts, which are presented in curriculum, have significant role in the understanding of the children. Concepts of different types, including science concepts, which are not properly attained or understood, can seriously affect the performance of the students.

The ‘concepts’ are an important part of thought, and play very significant role in mental processes. Because ‘concepts’ are integral part of the educational process, therefore, it is necessary to know what concepts mean, unless one know them, one

cannot understand the process of thinking. To understand this we should know what are concepts, its types, and functions, how they are acquired and understood, how they develop, and what the relationship of language is and thought in its understanding. So, to understand how the knowledge is gained and processed, we will have to understand the concepts.

Concepts

The concepts are used to deal with the world. We categorize our experience to bring order to it. Otherwise we would have to treat every stimulus encountered as unique. We would always be tied to our immediate situation, being unable to use our past experience in our assessment of the present. The world would be a confused, unanalyzed set of stimuli. Our knowledge of the world is comprised of concepts and relationships among the concepts.

Types of Concepts

Concepts can be divided into a number of types. However, there is no universally recognized taxonomy. Concepts are like people in this sense. People can be categorized in many different ways; like tall/short, educated/not educated, interesting/uninteresting, etc. Here are some useful types of concepts.

Object and event. Object concepts represent some physical thing at some location in real or imaginary space. Examples are planet, microbe, sun, moon, galaxy,

and virus. Event concepts pertain to time. They represent a particular class or sequence of events. Examples are hour and holiday. Some event categories are represented by scripts, because they constitute a more or less fixed sequence of events. Object concepts have been studied much more than event concepts.

Eight parts of speech. One can divide words up into eight classes: noun, verb, adjective, adverb, pronoun, preposition, conjunction and article. It can be argued that these words label different types of concepts.

Concrete and abstract. This distinction is known by several names: simple/complex, non-verbal/verbal and perceptual/abstract. Concrete concepts are very closely tied to our perceptions. They arise from direct experience. Examples are table, tree, and dog. Abstract concepts are much harder to see. Their component features may be quite obscure and variable to different people. Some examples are justice, freedom, art, and beauty. Abstract concepts are often built up from complex concepts (Cohen, 1983). Many school-taught concepts are quite abstract, which is one reason why students find some hard to learn. The subject of mathematics, for example, is based on a progressive accumulation of abstract concepts from component concept. Children who do not grasp an important component concept often lead to misconceptions.

Well-defined and ill-defined. Well-defined concepts have a clear set of defining features. Examples are square, number and molecule. Ill-defined concepts

lack clear-cut defining features. An example is artistic style. Many concepts used in everyday life are ill-defined, while many acquired in school are well-defined.

Artificial and natural. An artificial concept is constructed for a particular use, usually for an experiment. One may experiment with artificial concepts to study the learning of concepts that subjects have no prior experience of or that can be designed to answer some research question.

Natural concepts are existing ones that people in a given culture have constructed and used. Examples are tree, star, moon, sun, and person. Some are more natural than others. However, there is evidence that we are strongly predisposed to form certain concepts which are part of our evolution, so, such concepts seem very natural.

Conjunctive and disjunctive. Conjunctive concepts have two or more particular features. A stimulus must have three sides, and be a closed figure. An example is a triangle. Disjunctive stimulus must only have several features. Disjunctive concepts seem odd, and indeed are quite scarce in the real world. Disjunctive concepts are harder to learn.

Apart from the above discussed types of concepts, sometimes concepts are categorized according to their domain where they come from.

Categorization of concepts according to stimulus domain. People can also categorize concepts according to the stimulus domain they come from (Cohen, 1983). So, we have person concepts (extrovert, sister, and voter), scientific concepts (ion,

reptile, and gravity), legal concepts (tort, contract), mathematical concepts (prime number, square root).

Functions of the Concepts

Cognitive economy. Concepts also serve major functions in mental life. They divide the world into manageable units, this is called cognitive economy.

Predictive power. The second function is related to the prediction of that information, which is not readily available. This is called predictive power

Properties of Concepts and Culture

The properties associated with the concepts can fall into two sets. One is 'Prototypes' of the concepts. They are the properties that describe the best examples of the concepts. The other property can be 'Core' of the concept. They are those properties which are most important for being a member of a concept.

Prototypes can be determined by our culture, or they can be universal. For some concepts, culture clearly has impact on the prototypes. For example, the concept of 'grandmother' is culturally determined. But more natural concepts, prototypes are universal. For example, colors, animals, birds etc.

How do we can acquire the multitude of the concepts that we know? Some concepts are innate like 'time' and 'space' and others have to be understood or acquired.

Understanding and Acquisition of Concepts

Concepts are acquired in many different circumstances and they vary greatly in complexity. Ausubel (1968) suggested that concept learning can be divided into learning from exemplars and from words. Concepts are often taught in the classroom from words, with perhaps some actual exemplars as well. 'Core' of the concepts is 'Explicitly' taught whereas 'Prototypes' are learned through 'Experience'. The later can be learned by two ways; one is through 'exemplar strategy' and the other is 'hypothesis testing'. However, here are some other ways through which concepts are acquired.

Acquisition from instances. This mode has been the one most studied in laboratories. When one or more stimuli are repeatedly encountered, our minds seem to be attuned to picking out similarities between them and forming concepts around them. Thus, the repeated experience of certain stimuli may lead to an internal representation of them or their similarities. In some cases, the features of certain stimuli are so obvious to our senses that abstraction seems nearly automatic. Exemplars of stars, moon, and clouds are so perceptually salient and so different from just about everything else that we can form concepts around them with great ease.

Acquisition through language. Children acquire concepts through words as they grow older. During this process language plays a vital role; firstly, some important concepts abstracted by great thinkers and poets can be rapidly communicated to people through words, for example, Allama Iqbal (the national poet

of Pakistan) who wrote political philosophy through poetry. Secondly, language can speed up the learning of concepts. Thirdly, there are some concepts which can only be learned through language (Klausmeier, Ghatala, & Frayer, 1974). For example, some disciplines, such as philosophy and history, rely mainly on words to teach concepts.

Teaching and learning process mainly depends upon the use of language. A teacher can use language to emphasize a concept's defining features, which may improve learning and understanding.

However, some factors may affect the acquisition and understanding of concepts. Few major factors could be like this;

Individual differences. Conceptual understanding may be affected by the individual differences. Some variables such as age, intelligence, expertise and cultural background may affect what concepts are actually understood, and how categories are represented.

Cognitive style. A cognitive style is a general way in which a person structures and uses information. A style is a preferred way in which a person organizes data or does a task. Individuals try to choose their occupations and courses of study that are consistent with their styles. Some cognitive styles may also affect the understanding of the concepts.

For detailed description about concepts we must know its developmental processes. Without knowing the developmental stages of the concepts, it would be difficult to find the role of understanding concepts in the educational processes.

Concept Development

Concept development can be divided into two types. One is ‘general concept development’, and the other is ‘concept development in children’.

Conceptual Development in General

Development of a single concept. A variety of processes may be involved in development of one concept. Discrimination and generalization are clearly two. A concept may become narrower as non-instances are encountered or broader and more detailed as more exemplars are encountered and a person generalizes to them (Homa, Rhoads, & Chamblises, 1979).

Development of a conceptual structure. A conceptual structure such as taxonomy also may develop. This evolution can occur in a number of ways. Concepts can be added or deleted. Existing ones combined or broken up, attributes added to concepts, and new relations between them established. Such evolution is very important in education. Students are continually organizing and reorganizing conceptual structures.

Concept Development in Children

Children are more likely to learn concepts from words and their conceptual structure as they get older. Therefore, it is considered that according to Sigel (as cited

in Scholnick, 1983) a child has the basic developmental task of acquiring concepts needed to make sense of the world and learning its culture's labels for important concepts. Also, children get better understanding of word meanings from their contexts. Here we cannot ignore the development of the language and its link with concept development.

Having basic knowledge about the concepts, let us turn this debate forward to a more interactive mode of science learning and teaching. It is assumed that learner thinks about his own experiences, beliefs; understands, views, and personally constructs meaning to acquire knowledge. The proponents of this perspective of learning believe that children get knowledge and conceptions about the natural world and they have unique ways of expressing their understandings in class lessons. They look at this as a method of teaching and passing knowledge from a psychological perspective of learning that matches with the contemporary nature of science. This methodology of teaching is called 'constructivism'.

As we know that children can construct knowledge and make explanations about natural phenomena. They also develop beliefs and views of the natural world. Constructivist theory posits that learners develop concepts, ideas and beliefs about the natural world even before they receive formal instruction. Constructivism also views learning as a social process of making sense of early experiences.

Constructivism

Constructivism goes back well before the 20th century. Glasersfeld (as cited in Ebenezer & Connor, 1998) pointed out that its roots may be traced to the writings of a

little-known 18th-century Neapolitan philosopher, Giambattista Vico, who stated that a learner knows only the cognitive structures he or she has put together.

Many psychologists worked on the theory of constructivism. However, John Dewey was one of the first major contemporaries to develop this theory. According to Dewey education depends on action. For Dewey, mind is a means of transforming, reorganizing, reshaping accepted meanings and values, a means of attending to the lived situations of life. Dewey kept telling his readers, "Mind is active, a verb and not a noun" (Fosnot, 1996, p.126). Dewey stressed the importance of having a student's knowledge grow from experience. Knowledge and ideas came only from a situation where learners had to draw them out of experiences that had meaning and importance to them. These situations, according to Dewey, have to occur in a social environment, where students could come together to analyze materials and to create a community of learners who built their knowledge together (Southwest Educational Development Laboratory, 1995).

Constructivism emphasizes the importance of the knowledge, beliefs, and skills an individual brings to the experience of learning. It recognizes the construction of new understanding as a combination of prior learning, new information, and readiness to learn (Staver, 1998). Constructivism points out the utility and boundaries of what we can know. Individuals make choices about what new ideas to accept and how to fit them into their established views of the world (Brooks & Brooks, 1995). Smith (1995) asserts that according to the constructivists, knowledge refers to the internal mental construction of the individual.

The 'constructivist' positions which have dominated educational debate in recent times have ranged across aspects of learning, of teaching and science (Asoko,

2002). The core commitment of a constructivist position, that knowledge is not transmitted directly from one knower to another, but is actively built up by the learner, is shared by a wide range of different research traditions relating to science education. One tradition focuses on personal construction of meanings and the many informal theories that individuals develop about natural phenomena as resulting from learner's personal interactions with physical events in their daily lives (Driver, Asoko, Leach, Mortimer, & Scott, 1994). Staver (1998) also asserts that constructivism provides a sound theoretical foundation for explicating science pedagogy. In short the view that students construct their knowledge from individual and/or interpersonal experiences and from reasoning about these experiences is called 'constructivism' (Windschitl & Andre, 1998).

Philips (1995) claims that educational literature on constructivism is enormous and growing rapidly. That is why today, it is said to be the latest catchword in the educational circles is 'constructivism'. Constructivism can be divided into different types.

Different Types of Constructivism

The psychological theory of constructivism came from the seminal works of Jean Piaget and Lev Vygotsky. Due to widespread interests in this theory, a debate has been initiated between those who place more emphasis on the individual cognitive structuring process and those who emphasize the social effects on learning. Cobb described (as cited in Windschtil, & Andre, 1998) two distinct but complementary constructivist perspectives concerning knowledge construction. "*cognitive*

constructivism" and "*social constructivism*" have become common when talking about this psychological theory. So, cognitive and social constructivism can be considered as two types of constructivism.

Cognitive constructivism. The first type of constructivism is Cognitive Constructivism. According to Cobern (as cited in Rodriguez, 1998), this is also known as *individual* or *personal constructivism*, *radical constructivism* (von Glasersfeld, 1989), *Piagetian constructivism* (O'Loughlin, 1992), and *psychological constructivism* (Matthews, 1994). It is based on the work of developmental psychologist Jean Piaget. Piaget's theory has two major parts: an "ages and stages", which predicts what children can and cannot understand at different ages, and a theory of development that describes how children develop cognitive abilities (Chambliss, 1996). The theory of development is the major foundation of cognitive constructivist approaches to teaching and learning. Piaget's theory of cognitive development suggests that humans cannot be "given" information which they automatically understand and use, they must "construct" their own knowledge. They have to build their knowledge through experience. Experiences allow them to create mental images in their mind (Chen, Goldsmith, & Feldman, 1994). Cognitive prospective theories focus on both what students learn and the process by which they do so (Fosnot, 1996).

The role of the teacher and the classroom environment are important parts of Piaget's theory. The role of the teacher is to provide a classroom full of interesting things to encourage the child to construct their own knowledge and to have the ability to explore. The classroom must give the students the opportunity to construct knowledge through their own experiences. They cannot be "told" by the teacher.

There is less emphasis on directly teaching specific skills and more emphasis on learning in a meaningful context. A more detailed account on Piaget's theory will be presented in the next sections.

Social constructivism. The second type of constructivism is Social Constructivism. It is a theory developed by psychologist Lev Vygotsky. Vygotsky's theory is very similar to Piaget's assumptions about how children learn. However, Vygotsky places more emphasis on the social context of learning. Also, in Piaget's theory, the teacher plays a limited role whereas in Vygotsky's theory the teacher plays a very important role in learning. There is much more room for an active, involved teacher. Social constructivism argues that students can, with help from adults or children who are more advanced, grasp concepts and ideas that they cannot understand on their own. Unlike cognitive constructivism, teachers in social constructivism do not just stand by and watch children explore and discover. The teacher may guide students as they approach problems, may encourage them to work in groups to think about issues and questions, and support them with encouragement and advice. Therefore, sociocultural constructivist knowledge is socially constructed and mediated by historical, institutional, and cultural contexts (Wertsch, 1991).

There is a great deal of overlap between cognitive constructivism and social constructivism, but there is also a great deal that is different. Cognitive theorists might argue that social theories do not adequately account for the process of learning, and social theorists might report that cognitive theories fail to account for the production and reproduction of the practices of schooling and the social order

(Fosnot, 1996). Comprehensive account on Vygotsky's theory will be presented in the coming section.

Basic Influence on the Development of Constructivism

Jean Piaget (1896-1980). Setting aside the traditional way of depicting the biographies of the major constructivist theoreticians, instead their theories will be discussed in detail.

Piaget's Theory of Intellectual Development

Although Jean Piaget started his career as a biologist, but later on he developed interest in science and the history of science. He got deeper sense into the thought-processes of doing science. He became interested in the nature of thought itself, especially in the development of thinking. He was primarily interested in how knowledge developed in human beings. He conducted a program of naturalistic research that has profoundly affected the understanding of child development. He called it *Genetic Epistemology*, meaning the study of the development of knowledge. Because he was primarily interested in how knowledge developed in human organisms. Jean Piaget was very interested in the way that children think. Piaget's constructivism was based on his view of the psychological development of children. He believed that the fundamental basis of learning was discovery.

Piaget's theory is fundamental to constructivism. It implies the process of building, creating, or making mental structures instead of merely absorbing or

reproducing products. To Piaget, the child's mind is self-organized by a constant antagonism between internal, subjective mental states and external reality. In Piagetian theory there is no objective ontological reality. He identified these two processes involved in the construction of knowledge as *Organization* and *Adaptation*. Organization and adaptation are complementary functions. Through these two processes information is taken in via senses and organized as schema by adaptive means.

The Construction of Knowledge

According to Scott, Asoko, and Leach (as cited in Abell, & Lederman, 2007), Piaget described an interactive learning process whereby an individual makes sense of the world through cognitive schemes, which are themselves modified as a result of the individual's actions on objects in the world.

Piaget used constructivism to explain but not merely describe cognitive development (Flanagan, 1991). He concluded that children engage in qualitatively different kinds of thinking as they pass through various stages of development, meaning they do not learn by practicing adult knowledge. Piaget discounted the relative importance of maturation and was interested in the processes that emerge as children discard previous ways of thinking for new ones. Intellectual growth results from attempts of the child to solve problems, which in turn causes the child to continually reconstruct the external world through personal experience as internal representations.

Constructivism is described throughout Piagetian investigations, including investigations with class inclusion, physical causality, language, and the various applications of his classical tests to investigate concrete and formal thought. Although the tasks required of children by Piaget were very clearly arranged like a scientific investigation, children were free to respond in any manner. Piaget's intent was on discovering the differences in a child's thinking and what the child can or cannot do without adult assistance or instruction at any stage of development. But unlike the eager parent or teacher wanting a child to understand, dialogues of Piaget's interactions with children reveal a continual probing, an interrogation with no feedback. This progression occurs because of the reciprocal effects of assimilation and accommodation, constantly forced to attain equilibrium between subjective and objective states. As results of his studies he identified that two processes are involved in the construction of knowledge—*Adaptation and Organization*.

Adaptation. Piaget's central concern was with the process by which humans construct their knowledge of the world (Driver, Asoko, Leach, Mortimer, & Scott, 1994). According to Scott, Asoko, and Leach (as cited in Abell, & Lederman, 2007), Piaget called it an interactive learning process, by which an individual makes sense of the world through cognitive schemes, which are modified as a result of the individual's actions on objects in the world.

In most of his writing the knowledge is portrayed as schemata in the individual's head, the mechanism for changes in intellectual organization as a result of interactions with the world. He called this as adaptation. Adaptation has two

important components, which are called the processes of assimilation and accommodation.

Assimilation. Assimilation is an active response to a minor perturbation. By which an individual interprets particular sensory information in their existing cognitive structure. By this process knowledge is extended through assimilation but new knowledge develops and is made more complex through accommodation.

Accommodation. This is an active response to a major perturbation of the child's existing representations of the world, when new experiences do not conform to internal expectations, when the child is confused or astonished by something at variance with personal expectations or beliefs about how reality ought to be.

Assimilation and accommodation are the two sides of adaptation, Piaget's term for what most of us would call learning. Piaget saw adaptation, however, as a good deal broader than the kind of learning that behaviorists in the US were talking about. He saw it as a fundamentally biological process. Even one's grip has to accommodate to a stone, while clay is assimilated into our grip. All living things adapt, even without a nervous system or brain.

Assimilation and accommodation work like pendulum swings at advancing our understanding of the world and our competence in it. According to Piaget, they are directed at a balance between the structure of the mind and the environment, at a certain congruency between the two, that would indicate that you have a good (or at least good-enough) model of the universe. This ideal state he calls *Equilibrium.*

Equilibrium. Piaget used equilibrium or self-regulation to explain the development of knowledge. A child constructs knowledge, when his stable state of mind is encountered with a disturbance of discrepant event. In a class setting, if a teacher has to make learning successful, he must challenge the child with progressively more complex ideas. For a child if learning is possible, he will respond to the problem to get a new state of equilibrium. That results in the further knowledge construction.

Assimilation and accommodation according to Scott, Asoko, and Leach (as cited in Abell, & Lederman, 2007) cannot be dissociated: whenever an individual interacts with sensory information, both assimilation and accommodation take place. So, this is the process by which cognitive structure adapts in order to make sense of particular sensory information.

Although these two processes are involved in all the activities performed by the individual biologically or psychologically, however, their ratio may vary from each other. An act of relatively complete intelligence is characterized only when there is more or less stable equilibrium between these two. There could be different types of equilibrium between assimilation and accommodation in the process of development of intelligence in children. During the process of investigating the child development, Piaget noted that lot of variations takes place at each step of development. And so he developed the idea of *Stages* of cognitive development. These constitute a lasting contribution to psychology. The concept of cognitive structure is central to his theory.

Cognitive structures. These are patterns of physical or mental action that underlie specific acts of intelligence and correspond to stages of child development.

Drawing upon his body of empirical work, he proposed the account of conceptual changes based upon the development of content-independent logical structures. Characteristic stages in the development of logical thinking were set out, based upon children's abilities to perform tasks involving skills such as conservation and seriation.

Piaget argued that children construct knowledge as they actively attempt to understand the world, and they construct this knowledge differently as they move through certain developmental stages or levels of knowledge.

After viewing Piaget's above mentioned theory, one gets impression that it basically underpins the structures rather than content. He is interested in knowing in the understanding of the processes involved in behavior rather than control and predicting the behavior. And this is an on-going process of organizing and reorganizing the structure. This process carries some characteristics that try to ascertain some levels of stability (equilibrium) at a specific stage of development.

The Concept of Developmental Stages

The concept of stages is an important part of Piagetian theory and it constitutes a lasting contribution to psychology. According to Piaget, to reach an understanding of basic phenomena, children have to go through stages. Understanding is built up step by step through active involvement of the individual. It enumerates several important aspects of development; each stage is referred by certain characteristics, hierarchy of stage sequence is unchangeable, development is divided into different periods, every stage is linked with the other, and they are free from cultural variations.

He gave four primary cognitive structures; these are also called developmental stages:

The sensori-motor stage. The first stage is called sensori-motor. It starts from birth and lasts around two years. As the name denotes, the infant uses his senses and motor abilities to understand and interact with the world. This stage starts from reflexes and ends with complex systems of sensori-motor actions and reactions. Sensori-motor stage is further divided into different periods.

The first ever period is considered from birth to one month. Innate reflexes begin to function. In the start these reflexes are functional and afterwards are served for non-functional purposes. During this period the child is unable to differentiate between self and objects.

The period between first and fourth months, is called *primary circular reactions***.** Because during this period the child works just an action of his own which serves as a stimulus to which it responds with the same action. That action seems to be interesting, that is why he does it again and again. For example, the baby may suck her thumb. That feels good, so she sucks it again.

Between four and eight months, the child turns to the period of *secondary circular reactions*, which involve an act that extends out to the environment. She may squeeze a rubber duck. At this point, other things start to come up as well. For example, they begin to develop object permanence. This is the ability to recognize about those missing things, which you can't see. That means something doesn't mean it's gone.

The fourth period is characterized by *practical intelligence*. A problem is solved by applying existing schemes. Children remember, and may even try to find things they can no longer see.

Between twelve and eighteen months, the child works on *tertiary circular reactions*. This period consists of repeating the same interesting things with constant variation. This kind of active experimentation is best seen during feeding time, when discovering new and interesting ways of throwing the spoon, dish, and food. During this period, the child is clearly developing mental representation, that is, the ability to hold an image in their mind for a period beyond the immediate experience. For example, they can engage in deferred imitation, such as throwing a tantrum after seeing one after an hour.

Period six is the last one, starts from age eighteen and ends up to the age of twenty four months. Words are used to refer for such objects which are not present around. When a child confronts a problem, he uses mental combinations to solve that problem, such as putting down a toy in order to open a door. This is the time for a child to achieve the concept of permanence of objects. The object existence is separated from the self and its physical presence.

Pre-operational stage. The second stage is called pre-operational stage. Which lasts from about two to seven years. As the name suggests, this stage precedes a latter stage called an operational stage. Pre-operational stage is again divided into two periods: Pre-conceptual and intuitive periods.

Pre-conceptual period is normally considered from the age two to four years. The child is able to use *mental representations*; it is a step to use the symbols, signs,

and mental images. A child can symbolize the word. A symbol means something that apparently refers to something else. A drawing, a written word, or a spoken word comes to be understood as representing real objects. The most important example is the use of language, which plays very significant role in the mediated thought. With the usage of language, the child is able to recall actions and can repeat by imitating those actions. Creative play is another good example of using symbols. Along with this symbolization, the child is able to distinguish between past, present, and future. Although the child can imitate, defer, and explain the actions, however, she is incapable of reasoning inductively or deductively. Rather the child reasons transductively. Meaning that child believes that objects or events that occur together are causally related.

On the other side, the majority of the children are quite *egocentric.* They think that others also see the things from the point of view, as their own. They may hold up a picture and expect others can see it too.

The second period is called *intuitive*, which lasts from four to seven years. The intelligence is intuitive in nature. Children are not able to conserve when solving problems. Children are not able to account for the quantity of a solid or liquid when it changes shape. This is the period of greatest language growth during childhood. They tend to be ego-centric thinkers. Children are able to use mental images, imagination, and symbolic thought. They are capable of understanding simple rules.

There are overlaps between pre-conceptual and intuitive periods. Reasoning is an important feature among the intuitive children. They may use logic in exploring the events. Although, a child can pay concentration on more than one aspect of a problem, however, she is still not able to reach at the correct answer, reason being the

lack of ability to find the coordinated links of these aspects. Her answers of a situation are indications of partial coordination of actions of thought, which reflect incomplete mental actions. However, such actions pave the paths for logical explanations expected in the near future.

Majority of the children in Pakistan start their education in primary schools at the intuitive period. During the period of pre-operations the children of Pakistan are expected to be in classes one and two.

Concrete-operations stage. This stage begins from the age of seven years and ends up nearly at the age of eleven years. This is the stage where most of the Pakistani children would be in primary schools and expectedly studying between class three to five.

Now the child is operational. The word operations means logical operations or principles we use when solving problems. Although the cognitive structure during the concrete operational stage is logical, but depends upon concrete referents. In this stage the children can think about existing objects and its properties. In this stage, the children not only use representational symbols, but also can manipulate them logically. Their thinking is still limited to perform these operations within the context of concrete situations. During this stage, the children develop sets of reasoning strategies that signify their ability to perform on objects. Here are some significant strategies;

At the age of six and seven, majority of the children develop the ability to conserve number, length, and liquid volume. *Conservation* means that a quantity remains the same though it changes in appearance.

The development of conservation of substance starts at the age of seven or eight. For example, if you take a ball of clay and roll it into a long thin rod, or even split it into different little pieces, this is expected that the child knows that there is still the same amount of clay. And it is also expected that he will know, if you rolled it all back into a single ball, it would look the same as it did before. This feature is known as *reversibility*. The conservation of area is mastered at the age of nine or ten.

Learning *classification* and *seriation* is another important and added feature of a child during this stage. Here the child starts to get the idea that another set can be included (Boeree, 2006).

Seriation means, the ability of the child to put the objects in order using a property similar to all the things. The pre-operational child may start putting things in order by size, but it is not true classification. A concrete operational child has no problem with such a task. Not only can he easily manage the multi-dimensional classification but can also handle the class inclusion, which is the ability to comprehend that a class can exist within a set of classes.

Formal operations stage. Entering into the final stage of formal operations is a difficult time for applying new logical abilities, because in this stage, thinking involves abstractions. Therefore, this stage is characterized by the fulfillment of high intellectual accomplishments by an intelligent grown-up adult.

This stage starts at eleven years of age. Around twelve and on, the individual enters the formal operations stage. Gradually, he starts thinking in a competent style, like an adult. This thinking style involves logical operations, which are an abstract

thinking, rather than concrete operations. This style of thinking is called *hypothetical thinking*. Achieving this high point is regarded controversial in Piagetian theory.

Piaget contrived, logic is the source of maturity in human thinking. As the nomenclature of this stage reflects, the word *formal* is ingredient of formal logic that deals with the form of an event, rather than its contents. Which means that child is no more dependent on the contents of an event; he can now deal with its form. In this stage, the adolescent is free from the concrete operations. Such individuals do not need to manipulate objects to solve problems. They are capable of abstract thought and scientific experimentation, which includes generation of hypotheses and alternatives. The understanding of ethical and moral principles develops during this age. They are also capable of self-reflective thoughts.

This is not necessary that the formal operations stage is something everyone actually attains. Those who are at this stage don't operate in it at all times. Researches show even some cultures, don't develop it or value it like European culture does. Simply saying, abstract reasoning is not universal.

While the stages of cognitive development identified by Piaget are associated with characteristic age spans, they vary for every individual. Furthermore, each stage has many detailed structural forms. For example, the concrete operational period has more than forty distinct structures covering classification and relations, spatial relationships, time, movement, chance, number, conservation, and measurement.

Piaget's ideas and work has been very influential on student conceptions and conceptual learning. His account of how individuals come to know can be seen in much writing about students' conceptions, conceptual change and personal

constructivism. His theory has also been applied extensively to teaching practice and curriculum design particularly science curriculum and sequencing.

Discursive Turn in Psychology

Up till 1970s and 1980s, the accounts of the origins of student's thinking about the natural world tended to be based upon a Piagetian theoretical framework; knowledge portrayed in terms of entities in the individual's head, that develop through the individual's interactions with the material world.

In recent years, major shift in 'discursive turn in psychology' has focused away from cognitive processes in the individuals to social contexts. Developmental psychologists have explored the idea of the child as someone who negotiates meaning and understanding in a social context.

A major challenge to Piaget's model comes from the '*Perspectives of Learning in Social Context*' by the writings of Russian psychologist; Vygotsky, whose work was unknown to the West until the end of the twentieth century.

Reveles, Kelly, and Duran (2007) suggest socio-cultural psychology learning within an activity system is constructed through interaction of members of a community. They also assert that socio-cultural theory is an important teaching-learning perspective offering an expanded expressive potential for science education research.

Social Development Theory

Lev Semenovich Vygotsky (1896-1934). In recent years, according to Gergen's study (as cited in Rodriguez, 1998) sociocultural constructivist approaches have become more appealing to psychologists, educators and researchers, due to the over focusing of individual constructivism 'on the mental processes of the individuals, and the ways in which they construct knowledge. Although Piaget is widely regarded as the patriarch of constructivism, constructivists have embraced other theorists, especially the Russian psychologist, Lev Semenovich Vygotsky, a contemporary and minor critic of Piaget.

The theoretical approach he took to cognitive development is sociocultural, he worked on the assumption that action is mediated and cannot be separated from the milieu in which it is carried out (Wertsch, 1991).

Just like Piaget, he considered that child an active constructor of knowledge and understanding; but he differed from Piaget in his emphasis on the role of direct intervention by more knowledgeable others in this learning process. He proposed that it is the result of the social interactions between the growing child and other members of that child's community that the child develops the 'tools' of thinking and learning. According to him, this is due to cooperative process of engaging in mutual activities with more expert and knowledgeable children. Therefore, Vygotsky's major theme is that social interaction plays a fundamental role in the development of cognition. Vygotsky (1978) wrote: "Every function in the child's cultural development appears twice: first, on the social level, and later, on the individual level" (p.57). First, we meet new ideas in social situations, for example, different modes of communication,

such as talking, gesturing, writing, visual images and action. Vygotsky refers to these interactions as existing on the *social plane***.** It may involve teacher working with a class of students in school; it may involve a parent explaining something to a child. Thus these words, gestures and images used in the social exchanges provide the very tools needed for individual thinking. That is how these social tools of communication become *internalized* and provide the means for individual thinking, first, between people *Interpsychological* and then inside the child *Intrapsychological*.

This applies equally to voluntary attention, to logical memory, and to the formation of concepts. All the higher functions originate as actual relationships between individuals. In the first level language and psychological processes develop initially as social, interpersonal interactions among people. These are gradually "turned inward" or incorporated as internal tools, which he referred to as *Intrapsychological*.

Main Themes and Theoretical Approach of Vygotsky

After having some basic ideas about the Vygotsky's theory, it seems important to have detailed account of his main themes. Basically, as it has been stated earlier that Vygotsky believed that all mental functions are regulated among the people through social relations or relationships. Therefore, mental functions are regarded as key concepts in his theory; let us see how he understands the mental processes and functions.

Higher and lower mental functions. Vygotsky differentiated between higher and lower mental functions conceiving lower or elementary mental functions to be

those functions that are genetically inherited, which are natural mental abilities—the elementary psychological functions—as distinct from those that use the resources of cultural items to augment them. He considers the 'augmented abilities' as not just what are naturally given to us plus a bit extra, but as their being transformed into something quite different altogether. Natural abilities allow to do new things—like read—but in the same way as there are major differences in the way novice reader 'read' differently from proficient readers, so to do these kinds of abilities that arise through 'augmentation'—In contrast, he saw the higher mental functions as through social interaction, being socially or culturally mediated. At an elementary level the behavioral options are limited when functioning occurs. The learning that occurs at that level is without a result of social interaction, without self-awareness or the use of signs and symbols that allow us to think in more complex ways, humans would remain slaves to the situation, responding directly to the environment. Higher mental functions allow human beings to move from impulsive behavior to instrumental action. Cultured human differs from primitive humans and other primates in that they do not react directly to the environment (Wertsch, 1991). Today's psychology is mediated by cultural means. From infancy the humans learn through interaction with others.

Wertsch (1985) has commented that Vygotsky indicated four major criteria that distinguish between the elementary and the higher mental functions: (1) The shift of control from the environment to the individual, that is, the emergence of voluntary regulation; (2) The emergence of conscious realization of mental process; (3) The social origins and social nature of higher mental functions; and (4) The use of signs to mediate higher mental functions.

Intermental vs intramental psychological abilities. The terms 'Intermental' and 'Intramental' can best be described as 'between people', and 'within people'. Intramental ability exists within the child while Intermental ability occurs in the relationship between people. Initially, an infant cries are not intended by the infant to be a form of communication; their existence is simply an undirected expression. When they cry others act on their behalf giving meaning to their communication. She or he can communicate only through their relationship with others. This is an example of what Vygotsky means by an Intermental ability. At a certain point in the infant's development this changes with the infant's behavior becoming intentional. When an infant is able to use crying instrumentally, that is as an intentional act of communication the ability demonstrated is Intramental (Nicholl, 1998).

And when a parent gives meaning to the communication of their child and that child is unable to do so for itself, the parent is working, what Vygotsky called, in the child's *Zone of Proximal Development*, or ZPD. It was the concept of ZPD, through which, Vygotsky outlined some of his ideas about the relationship between interpsychological and intrapsychological functions.

The zone of proximal development. The key concept of Vygotsky's theory is the zone of proximal development that gives an explanation, how an infant learns with the help of others. This is the distance between the level of actual development and the more advanced level of potential development that comes into existence in interaction between more and less capable participants. This potential ability is greater than the actual ability of the individual when the learning is facilitated by someone

with greater expertise (Wertsch, 1991). Vygotsky suggested that interactive learning with adults is most effective in helping children cross this zone. He also believed that child is brought into the intellectual life of the society and develops his learning by collectively constructing her understanding of environment in the world. Contrary to Piaget, he argued that children learn from other persons who are more 'expert and knowledgeable'.

How is this 'expert intervention' brought into action so that a child can learn? Vygotsky asserted (as cited in Rodriguez, 1998) that there should be a level beyond the child's existing developmental level, so that it brings some challenge to the child; but it should not be ahead of the child's level, therefore, it is easily achievable. Therefore, ZPD is a process, which can be achieved and comprehended after fulfilling each process.

Vygotsky was the main critic of the psychological testing. He believed that existing techniques of psychological testing focused heavily on intrapsychological accomplishments and fails to counter in the predicting future development. He basically introduced the idea of ZPD to deal with this problem, which is an attempt to address the practical problems in educational psychology: the problem regarding the assessment of children's intellectual abilities and the evaluation of instructional practices. According to him, psychological tests do not resolve the issue of actual level of development, because, determining the mental age of a child with the help of tests is a big concern of determining the actual level of development. The important reasons for introducing ZPD is that it tries to deal with this problem; one can trace this problem of how a child become 'what he not yet is' (Wertsch, 1985).

The construct of ZPD allows to determine and examine such functions as are not mature or in the phase of maturation. According to Vygotsky, such functions are called ‘buds’ or ‘flowers’ of development. Vygotsky considered such ‘buds of development’ as interpsychological functions. Hence, the ZPD is considered as a genetic law of cultural development in the theory of Vygotsky. So, this is the dynamic, sensitive, and transitional region, in which a change from intrapsychological to interpsychological function is made.

The second way, in which Vygotsky viewed that ZPD is a useful construct, is the process of ‘instruction’. He argued a particular relationship between development and instruction. Regarding the specific forms of instruction, Vygotsky emphasized to structure interpsychological functioning in such a way that it increases the growth of intrapsychological functioning. He considered instruction as a social rather than the natural way of development that gives rise to higher elementary functions.

A general point can be concluded that the interpsychological functioning found in zones of proximal development may vary widely depending on the social institutional context in which this functioning occurs. However, such contexts are likely to be changed if the sociohistorical settings are also changed. The internalization of the inter-mental and intra-mental is mediated by cultural artifacts, which means that internalization is a part of concern with the social origins of higher mental functioning in the individual.

Vygotsky did not draw any useful boundaries as to pursue a point of inquiry. He did not operate within the limits of a single social science or humanities discipline. That is how Vygotsky considers the idea of ZPD as the range of potential each person has for learning, with that learning being shaped by the social environment in which it

takes place, and thus, through this process, the child or individual learns with the help of another. Through this social interaction in the process of zone of proximal development we learn how to use the psychological tools which are available to us.

Psychological tools and culturally mediated learning experience. Vygotsky viewed learning processes as the result of sociocultural mediation. According to him learning processes appear first as a process of appropriation by the child of the methods of action existent in a given culture. In such an appropriation, psychological tools play a crucial role in human cognitive development and learning.

The concept of psychological tools is the basic element of the Vygotsky's theory. Psychological tools are those symbolic artifacts such as, signs, symbols, texts, formulae, graphic-symbolic devices---that help individuals in mastering 'natural' psychological functions of perception, memory, attention, and so on. Psychological tools serve as a bridge between individual acts of cognition and the symbolic sociocultural prerequisites of these acts (Kozulin, 1998).

Since, distinguishing trait of Vygotsky's theory is its firm belief on the sociocultural aspect of human cognition. And human cognitive abilities are mediated by the symbolic psychological tools. The concept of the psychological tool began first as an example of material tool that suffice as a mediator between the object and the human hand. Change in material tool will change the entire life of the individual.

According to Vygotsky, basically there are two important sets of psychological functions; one is 'natural' and the other is 'cultural'. Natural functioning is observable in the child's cognitive functions in the form of development and maturation. But fundamental changes can occur as the course of

human history and civilization, which transform such natural functions into cultural ones. These changes are due to material and symbolic tools, these changes occur also in different forms of interpersonal communication taking place in the society.

Just like material tools, the formation of psychological tools is also artificial. But both are social in their nature. However, they differ in their functions. The processes in nature are controlled by material tools, whereas, psychological tools serve the responsibility in mastering the natural behavioral and cognitive processes of the person. In other words, material tools, serve as conductors of human activity, based on external world. However, on the other hand, psychological tools are considered to be internally oriented, serving the responsibility of transforming the internal and natural psychological processes into higher mental functions. The process of this transition from natural to cultural functions takes place both historically and in the form of personal growth.

From birth humans learn through interaction with others and in doing so they create something qualitatively different from what they started. What they learn depend on the psychological tools available to them and which tools are available will depend upon the culture they live. Their thoughts, actions, and experiences are culturally mediated. In Vygotsky's views, there is a dynamic influence of cultural factors on the child's construction of mental structure (Chen, Goldsmith, & Feldman, 1994).

Semiotic potential and the decontextualization of mediational means. In terms of concept development, Vygotsky was interested in the semiotic potential that is realized in the decontextualization of mediational means. This is the process where

the meaning of signs becomes less and less dependent on the peculiar space-time context in which they are used.

Decontextualization results in mastery of abstract forms of reasoning associated with the types of tasks found in formal education where words or terms are abstracted from the discourse or text that they were embedded in and become objects of reflection (Nicholl, 1998). Vygotsky (1962) believed, the central fact about our psychology is the fact of mediation.

Although Vygotsky's theory is heavily embarked by all higher mental functions, but he also emphasized the role between languages and thought that incorporate in the development of all such human functioning.

Language and Thought

Vygotsky emphasized that language is the reflection of our cultural forms in the shape of academic texts, professional practice, the arts, folklore, customs, gestures, symbolic play, children's drawings and scribbles. Without these aids or tools, which are provided by the history or culture, an individual can learn very little. According to Vygotsky, all these cultural tools help in shaping or forming the 'concepts'.

Therefore, Vygotsky's studies of thought and language were concerned about concept formation in children. He tried to elaborate a number of stages in the concept formation of the children. Vygotsky identified two interrelated types of active experiences, which lead to concept formation. According to him, the first type of experience is attending a well-organized and formal school. Attending the school can

help in understanding the academic 'scientific' concepts. Scientific concepts are presented in a very well-organized and systematic way that reflects the cultural and social models. Those concepts, eventually, are incorporated and used by the students consciously. The second type of experience, as argued by the Vygotsky regarding the concept formation is the 'everyday experience' of the students. This experience is rich in its nature, but it is featured as unsystematic and most of the time unconscious. Everyday concepts can be useful in every day context, but not when they are applied to solve the logical and scientific explanations (Kozulin, 1998).

According to Vygotsky, the understanding of science concepts does not take place abruptly, but it follows a process of essential development. Vygotsky believed that the process of the development of the scientific concepts is carried out through a mechanism of interaction between the way science concepts are presented to the child and child's own everyday concepts related to the same phenomena. He argues that science concepts develop from the 'top down', whereas, on the other side, the everyday concepts develop in opposite direction, from the 'bottom up' (Kozulin, 1998).

Further research in Soviet Russia has been carried out in two distinctive directions into theoretical versus empirical learning. And in the West, this distinction has been initiated by the researchers into problems related to misconceptions held by the students of learning science and problems related to conceptual differences between student and teacher. However, in the East, particularly in Muslim world, this issue has not been taken as a point of research seriously.

It has been mentioned earlier that many people in the West based their work on the theoretical grounds of Vygotsky's theory. Not only was his theory proved on

scientific basis but also extended and applied in different dimensions of social, psychological, and educational variables. Jerome Bruner is one of the prominent personalities whose work is highly regarded in supplementing the work of Vygotsky in educational settings.

The Impact of Bruner

Jerome Seymour Bruner (1915-). The person who used, developed, and applied extensively the ideas of Vygotsky in educational settings is the American psychologist Jerome Bruner. He was born October 1, 1915 in New York City.

Similarities of Vygotsky and Bruner

Vygotsky's views regarding the thought and language as keys for action were quite similar with Bruner's ideas. He was in total harmony accepting Vygotsky's suggestion that society is the source providing the tools that enables the child to become as a learner and thinker. He showed a special interest in the concept of zone of proximal development. He was also interested in the role of other individuals in 'helping' the child to learn, mastery, and reflect on things. He gave the name 'loan of consciousness' to this help. Where the Vygotsky was unable to describe any detail how the more expert adult might 'lend' consciousness to the child who did not already have it (Smith, Cowie, & Blades, 2003).

Major Themes of the Theory of Bruner

One of the major themes in the theoretical framework of Bruner is that learning is seen as an active process in which learners construct new ideas or concepts based upon their current and past knowledge. This is learner who selects and transforms information, constructs hypotheses, and makes decisions, relying on a cognitive structure to do so. Cognitive structures mean schema and mental models, those which provide meaning and organization to experiences.

Bruner and 'instruction'. As far as instruction is concerned, the instructor should try and encourage learners to discover principles by themselves. The instructor and learner should engage in an active dialogue (i.e., Socratic learning). The task of the instructor is to translate information to be learned into a format appropriate to the learner's current state of understanding.

Bruner's constructivist theory is a general framework for instruction based upon the study of cognition and it addresses some basic aspects; (1) Instruction must be concerned with the experiences and contexts that make the student willing and able to learn (readiness). (2) Instruction should be designed to facilitate extrapolation and or fill in the gaps (going beyond the information given). (3) Instruction must be structured so that it can be easily grasped by the learner (spiral organization).

The concept of 'spiral curriculum'. Curriculum plays an important role in the construction of knowledge and passing on information to the children. According to Bruner curriculum should be organized in a spiral manner so that the student continually builds upon what they have already learned. Bruner's theoretical

assumptions can be applied to subject matter across various curriculum. Specifically those yield to process the results. Learner and instructor have particular role in instruction that give room to the learner to develop meaningful knowledge of the subject matter. In Bruner's approach, the results are not controlled only by the learner or the instructor for the development of useful knowledge construction. By using a spiral curriculum, the learner builds on previous construction of knowledge to formulate more useful associations and authentic meanings. Guidance provided by the teacher for instruction through the appropriate environment for learners, results in the construction and rationalization of newly formed understanding of concepts and knowledge (Cherry, 2004).

Language as a tool. Here the role of language cannot be ignored, if the learning has to take place appropriately. Bruner emphasizes the effective use of language in the understanding and acquisition of knowledge.

Bruner and 'schooling'. A learner gets experience, constructs the knowledge, and interprets the cultural ideas from the physical world. The school is the active part of the physical world. Bruner mentions that 'schooling' can create a lot of impact on the nature of thinking, because schooling carries specific ways of looking at problems and of acting on the world. According to him, teachers are not merely handing on knowledge but actively recreating diversified ways of thinking. They can enable or inhibit the knowledge by using successfully or unsuccessfully 'scaffolding'.

The concept of 'scaffolding'. The idea means that a child is only able to take the next step in her cognitive development if another person---typically an adult---supports and prompts her to do so. This sort of assistance has been called scaffolding. This refers to a wide range of activities by which the adult, or the more knowledgeable person, assists the learner to achieve goals or help children to develop their cognitive skills, which would otherwise be beyond them, for example by modeling an action, by suggesting a strategy for solving a problem, or by structuring the learning into manageable parts. Special care is taken not only of the child's existing level, but of how long a child progresses with the help; this is quite similar idea of Vygotsky's ZPD. An important aspect of scaffolding is that there is a gradual withdrawal of support as the child's knowledge and confidence increases.

Scaffolding is a guided participation that permits the beginners to enhance their familiarity and control over the diverse activities involved in a particular culture. Sometimes knowledge is presented in the form of narratives or stories which is socially and culturally embedded in a specific culture.

Stories or narrative knowledge. The knowledge communicated through narratives or storied discourse contains worthwhile and thoughtful cognitive rationality. In recent years this form of knowledge generating has received a significant attention in the domain of cognitive psychology. Bruner is one of the notable contributors to this challenge. In his famous book, *Actual Minds, Possible Worlds,* Bruner (1986) asserts that there appear to be two broad ways in which human beings organize and manage their knowledge of the world; there are two distinctive modes of thought of cognition or rationality. He proposed one traditional logical-

scientific mode or way *paradigmatic cognition* and storied knowing *narrative cognitive.* Both paradigmatic and narrative or storied discourse communicates and generates useful, worthwhile, valid, and thoughtful knowledge.

Summing up Theoretical Issues and Reasons for their Selection as Models

Critical notes on the above-mentioned theoretical perspectives is not being presented, due to reason that the objectives of the present research is not to test the theories per se, rather, to get insight about the phenomena under the study on scientific basis using these three theoretical perspectives. Nevertheless, a little comparison between these perspectives is necessary to mention.

In Piagetian perspective, teacher plays an important role of facilitator who provides the appropriate material for the child's level of development and helps the child to 'discover' by herself. The teacher plays a passive role. He allows the child to tackle the conflict between her existing schemas. The teacher does not come in front to the child; rather he stands back and permits the child to find out ways for herself.

While on the other side, according to the views of Vygotsky and Bruner, the adult and child can work together to construct new schemas, and the child's thinking can be increased positively by intervention of a more expert person. The adult's expertise should be successfully engaged to the child's level of competence and to the ZPD. Concepts are constructed with the help of others who already embody them, together with the ways of thinking and doing that are cultural practices. The concepts including science concepts are recreated with children through the process of formal and informal teaching.

Viewing above discussed theoretical frameworks, one can reach to the conclusion that learning concepts involve learning to use the ideas of science to interpret, explain and explore events and phenomena in the natural world. This is a long term process which can be difficult. According to Vosniadou (as cited in Harnqvist & Burgen, 1997) misconceptions arise, knowledge may not be applied outside the classroom context and, even following extensive instruction, learners may hold on to their original ideas. Investigating misconceptions can lead to exciting science lessons (Bar, Ever, & Zinn, 2000). Multiple processes may be involved in the development of the concepts, whether alternative or misconcepts. The child may learn those concepts from different sources through which she has the interactions in her life.

To undertake a psychological research on children and their understanding of science concepts specifically within cultural context will lead to think about the complex creation, nature, and conception of human beings, and the unique universe in which they belong to.

Considering the Islamic context, that is the main source of inspiration and way of living of any Muslim culture and society. Typically, Muslims get guidance from Quran (a divine revelation) and Sunnah (the way of holy prophet Muhammad (PBUH), in their collective as well as individual lives. There are enough indications of distinguishing characteristics about how to deal and tackle with the children according to the Quran and Sunnah. Such commandments and instructions can also be attributed as the models. According to these sources, human beings hold special status in the whole universe; they differ in all aspects from the other creatures, therefore, they are called ‘super creature’ in the holy Quran. Hence, they are super creatures;

therefore, they should be dealt with special care. Several sayings (Hadith) of the prophet Muhammad (PBUH) and verses in the holy Quran can be referred to indicate how to deal, guide, teach, and to interact with the children to better educate, to pass on well-understood concepts, and very well-transmitted knowledge so that they should become healthy and fully functioning human beings. Here, some more relevant sayings of the prophet Muhammad (PBUH) are presented for better understanding how the prophet envisaged this phenomenon:

"Every child is born on the [true] nature [of God] but his/her parents make him/her a Christian, Jew, or Magian" (Hadith - Bukhari 2.440, narrated by Ibn Shahabad).

This saying reflects clearly significant influence of parents, those comprising of a family, and the members of family definitely belong to some culture or cultural groups. Therefore, they guide and instruct their children as they want to do. That means, initial process of construction of knowledge of which, the understanding of concepts are the integral part. The parents, in other words the society or culture play an important role. So, this is inferred that this saying of the prophet relates to the social or cultural perspectives of the constructivism.

There is another important saying of the holy prophet reflecting a relation between stages/ages and mastery on the performing the task of prayer. According to the words of the prophet Muhammad (PBUH):

“You should make your child learn how to say prayer at the age of five, and then order him to pray at the age of seven. And beat him [lightly] if she/he does not do so by the age of ten” (Hadith - Dawud, narrated by As-Saburah).

This saying indicates a clear link between developmental stages and the acquisition of knowledge.

Both of these famous sayings reflect that the process of development and acquisition of knowledge does not take place in isolation. Therefore, children cannot be isolated from the human beings. This means that it is basically a holistic phenomenon. Therefore, no single framework is sufficient to address this complex situation. So, in order to understand this phenomenon on psychological basis, it is better to view this issue from differing theoretical perspectives capable of holding holistic and comprehensive views about children's concept development from different angles, to get a clearer picture of the issue, instead of picking up one narrow and limited framework. Such view points are required which are multidisciplinary in their essence covering wide field of philosophical questions related to developmental issues as well as in-depth details of the classroom process, encompassing from teaching to curriculum, peers, elders, teachers to artifacts, and books to media etc. Hence, viewing and considering the competing theoretical view points in the field of psychology, two main streams and one recently developed framework (Piaget, Vygotsky, and Bruner) respectively fulfill the need for selecting the appropriate theoretical frameworks. Therefore, viewing all these issues, the selection of cognitive development theory of Jean Piaget, social development theory of Vygotsky, and cognitive theory of Bruner seems justified for looking at such varied and complex intricacies of education, understanding of concepts in cultural contexts of the children of Pakistan. These theoretical frameworks provide enough support to view constructive phenomena in total context ranging not only the development of the children but social, cognitive, and cultural aspects of the individuals, which are the

most significant factors in the understanding of the science concepts. These theories are based on solid scientific grounds. Therefore, it was decided to take these important contemporary theoretical perspectives as models to address all these issues and other related questions for a scientific study.

In the present study, it will be tried to examine how children come to understand the natural world through different modes of learning. These are the primary sources of interactions, mainly prevalent in the culture and surroundings of the children. Whether, these are through education, courses taught, media or narratives in the forms of stories etc.

Review of Literature

Indigenous Researches

Apart from the government level, the academicians and researchers from social sciences particularly, psychologists, educationists, sociologists, and anthropologists have contributed very little to ameliorate the present situation of education in Pakistan. This is evident while scanning the literature produced by psychologists and educationists within the country. One gets impression that no remarkable literature is available which is directly related to the present study. For this purpose available books, related researches, and journals were scanned in the library of National Institute of Psychology, Islamabad and some other libraries in the country. While on the other hand the material on the issues discussed under the present study is frequently available at international level. But it stands for the

Western and developed world alone, not in Pakistani context. There is a complete dearth of useful research work in this regard. One can hardly quote any worthwhile effort which was made to studying the problems and issues related to science concepts and cultural relevance.

Though, little research work is done by the psychologists and academicians yet a few studies can be reported, using and applying the theories of Piaget and Vygotsky in educational settings, though such studies are not directly related to the present study. Anyway, a brief survey is presented here just to know the trends of psychological and educational researches in Pakistan.

Here the role of National Institute of Psychology is worth mentioning that undoubtedly takes the lead in initiating remarkable efforts in introducing the Piagetian style of research in educational settings in Pakistan. While talking about Piagetian research in Pakistan, one gets acquaintance with a prominent psychologist, academician, and researcher, Dr. Muhammad Pervez, a retired professor of psychology by now. Pervez (1992) conducted a study on Piagetian construct of concrete operational thought and saw its relevance to the Pakistani school children. He saw drop outs from schools as one of the major problems of primary school education in Pakistan. He viewed a theoretical model in studying the children in educational processes while rejecting mechanical view of human beings. He observed that educational practices are not in harmony with the cognitive levels of children in Pakistan. The analyses of the textbooks of class 1 showed no relevance for the given cognitive levels of the children at this stage. This study did not encompass the other developmental stages given by Piaget. Hence, the other classes of school education could not be studied.

Psychologists and educationists employ intervention methodologies to see their effectiveness in instructions and educational processes. Iqbal (1997) employed the intervention lessons within the parameters enumerated by Piaget and Vygotsky, and saw its effectiveness on the cognitive development of science students from secondary schools of Lahore. The results showed that intervention strategies had profound effect on the cognitive growth of the experimental subjects. These subjects performed better on achievement tests in science and mathematics as compared to the control subjects.

Psychological studies carrying cognitive and developmental variables started almost three decades ago in Pakistan. However, psychological studies related to social and cultural factors affecting cognitive and educational variables have yet to seek attention of the researchers. Despite this fact, very recently, an effort has been done by Memon (2006), studying the determinants of social factors influencing girls primary education in rural areas of Sindh. This study is limited in its scope because, only female primary school teachers have been interviewed through an interview schedule, and further data has been collected through a custom-made questionnaire, ignoring the students and parents. The major social factors affecting the girls primary education were identified in this study are like poverty, shortage of female teachers, early marriage system, illiteracy, feudalism, religious hurdles, harsh attitude of teachers, absenteeism among teachers, inadequate trained and poorly paid teachers, transportation, female teachers safety concern, caste and race disturbance, social inequality, irrelevant curricula, and negative social attitudes greatly affect the female participation in education.

As evident from the above discussion, the exploration of science knowledge of the children from different sources has not been a major area of research in Pakistan. Textbooks are considered as one of the major sources, through which science knowledge is portrayed and disseminated for effective learning to the children. The effective use of textbooks is very important for the teachers to transfer knowledge to the children. A study was conducted by Muhammad and Kumari (2007) signifying the role of textbooks play in teacher's experiences and practices in their classrooms in rural areas of Sindh. The results showed that the teachers did not perceive textbooks as an important teaching and learning resource. Muhammad and Kumari believed that teachers somehow got the impression that the textbooks does not have much importance or could not play in providing children opportunities for meaningful learning.

Researches at International Levels

The present research encompassed a wide and varied range of research areas relating to understanding of natural science concept studied through natural phenomenon of moon focusing as a scientific object in science studies from a constructivist perspective; critical examination of cultural artifacts including analysis of textbooks; interviewing with the parents and teachers; analyzing the media and newspapers as possible sources of links with conceptual understanding. This wide range of subject area demanded a robust and comprehensive scanning of the literature. Therefore, a rigorous attempt with zealous hard work was required to cover the huge

body of related literature and researchers, entailing from qualitative to quantitative and experimental to theoretical studies.

As it was mentioned in the starting paragraph in the under the heading of 'review of literature', notice-able work has been initiated in the West. Therefore, upcoming passages will cover important related researches done internationally in this regard.

Research over the last five decades gives much information regarding the children's thinking and understanding about natural phenomenon. The research has also given much insight into children's ideas and understanding to science and the process of conceptual change. This knowledge change has been explored and interpreted from different perspectives. Mainly a clear cut trend characterizing student's science concepts learning can be seen from the individually oriented perspectives of Piaget towards sociocultural perspectives of Vygotsky.

Teaching, learning, and acquisition of concepts is one of the aspects that have been studied on a large scale. Research on this area started hardly five decades ago. The aim of this section is to overview different historical trends in the way in which research on understanding of science concepts have developed over the past fifty years or so.

Science concepts including natural phenomena are integral part of the science education. The concepts used in science education should help a person to become a good individual. The conceptual clarity should help an individual to deal effectively the daily life problems. That is why today the knowledge of science education is emphasized everywhere in the world.

Science Education Research

'Science should be taught to every student every day of every year while the student is in the school'. This is the manifesto adopted by the National Science Teachers Association (NSTA) of the US at the 1982 meeting of its Board of Directors that stated the new function for science in school program. Brunkhorst and Yager (as cited in Caduto & Bruchac, 1994) were funded by the National Science Foundation (NDF) of US for a research effort namely, project synthesis, for developing criteria for excellence in science education and the use of criteria to determine the discrepancies between what is in practice, what should be in practice in schools with respect to science education.

The NSTA has also asserted that the major goal of science is to develop scientifically literate individuals who understand how science technology, and societal influence one another, and who are able to use this knowledge in everyday decision making.

The NSTA also adopted a list of attributes, which describe a scientifically literate person. The list contains thirteen attributes with the topmost attribute, which in fact is an explanation of concept-clarity. These attributes include science concepts, process skills, and values in making responsible every day decisions'.

Due to these steps taken officially, the researchers and academicians focused their attention towards the science education research. The past decades have seen the growth of an extensive body of science education literature concerning children's science concepts (Tytler & Peterson, 2004).

Culture and science education. Cultural psychologists and child development researchers and theoreticians have recognized that culture and society play an important role in cognitive development (Vygotsky, 1978; Wertsch, 1985). Greenfield (as cited in Solano-Flores & Nelson-Barber, 2001) commented that culture influences the ways in which people construct knowledge and create meaning from experience.

In the past two and half decade, science education research has begun to address some of the social and cultural issues. Lemke (2001) gave an idea of numbers of items retrieved by searches of the ERIC (1996-1999) for researches conducted in 'science education' in the following areas; Cultural (1836), Social (2532), Language (2201), and Racial (484); these figures show that largest focus of attention have been on social and cultural issues. This is an indication that science education research as an institution is gradually widening its range of contributing perspective towards more truly global issues.

Natural Phenomena and Science Education

Children construct knowledge and explanations about natural phenomena. They also develop beliefs or views of the natural world. Lee (1999) argues that Children's knowledge and world views are products of sociocultural influences as well as individual construction. Driver, Asoko, Leach, Mortimer, and Scott (1994) have also asserted and viewed that scientific knowledge is socially constructed, validated, and communicated in a social process. They have shown that learners of science have everyday representations of the phenomena that science explains. These

representations are constructed, communicated, and validated within everyday culture. However, some times the scientific explanations of phenomena, with their characteristic rationality and generalizability, are often at odds with the informal explanations given by young learners. This discrepancy gives rise to the term *alternative conception* for the learner's explanation (alternative to the scientific conception). Alternative conceptions have the general characteristics of being poorly articulated, internally inconsistent, and highly dependent on context (Windschtil, & Andre, 1998).

Two contrasting epistemological approaches of Piaget and Vygotsky have been studied by Jie-Qi, Goldsmith, and Feldman (1994) to investigate the children's ability to make distinctions between those objects which are natural and those which have been created by the people. The objective of the study was to explore two questions; (a) whether there are changes with age in understanding the specific distinction between natural and man-made phenomena, and (b) if an appreciation of this distinction influences children's beliefs about the possibility of altering or transforming different categories of objects. The results showed that distinctions made by children between the natural and crafted objects are powerful organizer for adults as well as by the children, when they enter school.

Efforts have been done in the schools and classrooms to motivate the students and minimize the misconceptions about the natural phenomena. Robert (1992) tried to excite students about the scientific approach to viewing the natural world. For this purpose he used laboratory exercises for personal observation, data collection, and model development. The researcher achieved the main objectives of this exercise by introducing science and non-science students to the importance of observation and

critical thinking in the scientific method and also actively engaging the students in the process of science.

Piagetian tradition of research allows studying the understanding of the moon as a natural phenomenon in the form of interview schedule. To get insight into the children's ideas and understanding of the natural phenomena, Piaget conducted his main studies asking questions about celestial objects, like earth and moon from the children. This is called clinical interview. The detail about this method will be discussed in the subsequent part of the next chapter.

Let's have a detailed understanding about the natural phenomena of the moon.

The Moon

From the dawn of civilization, the moon has been a source of mystery and wonderment for men. Man has written stories, created myths, folk tales and fables, composed poetry and songs, calculated time, photographed, studied, theorized, and been challenged, aroused, and inspired by the moon (Ratto, 1971). Since time immemorial, moon has been a source of fascination and inspiration for all of us. References of the moon have been used in different forms. Scientists and astronauts have also made various successful attempts at not only studying the moon scientifically but also visiting it.

The origin of the moon. Over the history, there have been different theories of the origin of the moon prevalent in the different times and in different cultures.

At present the most acclaimed and accepted theory of the origin of moon holds that when the Earth was formed about 4.5 billion years ago, some other relatively smaller planets were growing. One such planet hit the Earth's surface while in its developing phase, giving out rocky debris and resulting in the formation of moon.

Moon and science. Apollo was the first successful space mission involving moon landing, accomplished by Neil Armstrong. This mission allowed scientists to understand the Earth's satellite better. After the Apollo mission, research on the science of moon, and the possibility of a trace of life there, gained momentum.

The Moon is the nearest body to us in space. It is a natural satellite which orbits the Earth at a distance of 380,000 kilometers. The Earth is held in its orbit around the Sun by the Sun's gravity. In the same way the Moon is held in its orbit by the Earth's gravity.

The Moon has a diameter that is about a quarter of that of the Earth. It occupies about one fiftieth as much space as the Earth. The Moon is exceptionally small relative to the Earth: a quarter the diameter of the planet and 1/81 of it's mass. The Moon's surface area is less than one-tenth that of the Earth; about a quarter of the Earth's land area. However, the Earth and Moon are still considered a planet–satellite system, rather than a double-planet system, as their common centre of mass, is located about 1,700 km (about a quarter of the Earth's radius) beneath the surface of the Earth.

The Earth is about 80 times heavier than the Moon. The surface of the Moon is marked with large craters. Scientists think that these were formed when huge rocks fell on to the Moon in the final stages of its formation. The dark areas on the Moon are called seas, but there is no water in these areas.

The gravity on Earth is stronger than that on the Moon. A person on the Moon would weigh one-sixth of what he would weigh on Earth. There is no air surrounding the Moon, and there is no water there either. So, no life can exist on the Moon.

The Moon affects the Earth in a number of ways. One of the ways in which it affects the Earth is to cause tides. It is the rising and falling of the sea. On any coast, the sea gradually rises. The highest point is called high tide. About 6 ¼ hours later the sea is at its lowest height. This is called low tide. On some coasts the difference between high and low tide is only about a meter in height. In other places the difference can be much greater.

Tides happen because of the Moon's gravitational pull. This force is strong enough to cause the water in the oceans and seas to swell or bulge, on the Moon-facing side of the Earth. Another bulge occurs on the far side of the Earth, as the Moon pulls the Earth away from its water. As the Earth rotates, both bulges travel around the oceans as high tides, with low tides in between (Horsburgh, 2002).

The revolution of the Moon around the Earth makes the Moon appear as if it is changing shape in the sky. This is caused by the different angles from which we see the bright part of the Moon's surface. These are called "phases" of the Moon. Of course, the Moon doesn't generate any light itself; it just reflects the light of the Sun. The revolution of the Moon around the Earth makes the Moon appear as if it is changing shape in the sky. This is caused by the different angles from which we see the bright part of the Moon's surface. These are called "phases" of the Moon. Of course, the Moon doesn't generate any light itself; it just reflects the light of the Sun. The Moon passes through four major shapes during a cycle that repeats itself every 29.5 days. The phases always follow one another in the same order.

What we see when we look at the moon depends on its location in relationship to the Sun and Earth. We see a different fraction of sunlight being reflected from the Moon to Earth.

Although this cycle is a continuous process, there are eight distinct, traditionally recognized stages, called phases. The phases designate both the degree to which the Moon is illuminated and the geometric appearance of the illuminated part. These phases of the Moon, in the sequence of their occurrence (starting from New Moon), are as follows:

(1) New Moon - When the Moon is roughly in the same direction as the Sun, its illuminated half is facing away from the Earth, and therefore the part that faces us is all dark: we have the new moon. When in this phase, the Moon and the Sun rise and set at about the same time.

(2) Waxing Crescent Moon - As the Moon moves around the Earth, we get to see more and more of the illuminated half, and we say the Moon is waxing. At first we get a sliver of it, which grows as days go by. This phase is called the crescent moon.

(3) Quarter Moon - A week after the new moon, when the Moon has completed about a quarter of its turn around the Earth, we can see half of the illuminated part; that is, a quarter of the Moon. This is the first quarter phase.

(4) Waxing Gibbous Moon - During the next week, we keep seeing more and more of the illuminated part of the Moon, and it is now called waxing gibbous.

(5) Full Moon - Two weeks after the new moon, the moon is now halfway through its revolution, and now the illuminated half coincides with the one facing the Earth, so that we can see a full disk: we have a full moon. As mentioned above, at this

time the Moon rises at the time the Sun sets and it sets when the Sun rises. If the Moon happens to align exactly with the Earth and Sun, then we get a lunar eclipse.

(6) Waning Gibbous Moon - From now on, until it becomes new again, the illuminated part of the Moon that we can see decreases, and we say it's waning. The first week after full, it is called waning gibbous.

(7) Last Quarter Moon - Three weeks after new, we again can see half of the illuminated part. This is usually called last quarter.

(8) Waning Crescent Moon - Finally, during the fourth week, the Moon is reduced to a thin sliver from us, sometimes called waning crescent.

A while after four weeks (29.5 days, more precisely) the illuminated half of the Moon again faces away from us, and we come back to the beginning of the cycle: a new moon. Sometimes, when the Moon is almost new, it is possible to dimly see its darkened disk. The light from the Sun cannot reach this part of the Moon directly; but at this time the Earth (as viewed from the Moon) is at its full and very bright, and what we see is light reflected from the Earth, that then bounces back at us from the Moon. It's a long trip for this light: from the Sun to the Earth, to the Moon, and back to the Earth.

Moon Phase Comparison. The moon's cycle is a continuous process that is in constant change. The moon never stays at any one phase for more than an instance in time. Starting with a new moon on day one and ending with a waning crescent moon on day 29, the moon's light shape and intensity is always changing.

The moon reaches a major phase every seven days after the new moon. The first of which is the first quarter moon occurring after 7.4 days. Between the new and first quarter is the time of the waxing crescent moon. 14.8 days into trip around the earth we see a full moon, but not before the waxing gibbous make an appearance. After the full moon a state of waning begins on the 15th day. Along with a last quarter moon both a waning gibbous and crescent moon is visible before a new moon cycle starts a new on the 29th day.

Moon Phase Misconception. The most common incorrect reason given for the cause of the Moon's phases is that we are seeing the shadow of the Earth on the Moon! But this cannot be correct: when the Moon passes through the shadow of the Earth, we get a lunar eclipse. Anyone who has seen a lunar eclipse, though, might remember that the Moon actually passes through the Earth's shadow only rarely, so that can't be why the Moon has phases. The real reason for the Moon's phases depends on two things: the Moon is round, and the angle it makes with the Earth and Sun changes over its orbit (Cooley, 2001).

Why Moon as an object for the study?

The moon has always been the focus of mythologies and beliefs, and literature is replete with fables surrounding it. One such famous fable says that full moon brings out the worst behavioral changes in humans and animals. It also increases the frequency of tides in the oceans and seas. However, objective studies do not support

these beliefs. Despite all the scientific reasoning, it seems as if the myth regarding the moon will remain popular in the masses because of strong traditional beliefs. Particularly the moon has been part of our cultural heritage for centuries (Smith, 2003).

Due to its beauty, the moon will always remain a source of inspiration for us. Scientists and researchers will continue to explore its mysteries as it smiles benignly on us (Khan, 2006).

Therefore, the moon is an excellent object of study to observe and understand the natural phenomena. It is a celestial object with which we are all familiar. Countless legends are associated with its phases, origin, and romance. It has been the subject for the poets for poetry. Calendars in many cultures are based upon its cycles. Most people have heard the terms harvest moon, new moon, and blue moon (Cummins, Ritger, & Myers, 1992). Because the moon is so familiar to us, it can be extremely useful to investigate to get the better understanding of the natural phenomena from the school children.

Indigenous Pakistani Cosmology of Moon and Children's Concepts

Typical Pakistani society is a blend of Muslim cultural and religious traditions. In that context, the conceptions of the universe, world, and natural phenomena of moon, sun, earth, and day/light, are intertwined with the elements of religious and theological fabric of religious traditions. So, the moon is an important part of Pakistani culture. The moon is described in literature; several stories, poetry, and folklores. Even in religious rituals and practices, the observance of moon has a special

relevance. For example, cultural heritage includes the celebration of Eid at the end of the holy month of fasting (Ramadan). After this another Eid following the tradition of sacrifice of the great prophet Ibrahim and performing the big pilgrimage (Hajj). Lunar phases have become the basis of the calendar that influences the daily life of Pakistani people. Many cultural festivals fall on the days of the phases of the moon.

Pakistani acquire concept about the moon from daily experiences and in schools as well. As a result, the moon is the most familiar heavenly object to most of the Pakistanis. However, people take the phenomenon of the moon for granted. While one might expect a sound knowledge of astronomy among Pakistani people, in fact, many retain understanding of the moon that is not compatible with scientifically held concepts. This conflict between culturally based moon and scientific concepts poses a problem for primary school children.

Being predominantly a Muslim culture and society, like other many Muslims countries including Pakistan, historical sources about the phenomenon of moon can be revealed from the religious teachings, literature, and traditions. In the Muslim context, the most important sources of revealing the knowledge about the moon, astronomy, and other celestial objects can be the Holy Quran. Among all the Muslim societies, the understanding, teaching, learning, learning by heart, and recitation of Quran is a religious and obligatory ritual. Most of the time, this starts from the early years of the child, even pre-school children are taught as they start developing learning language skills. The learning of Quran starts from the grade one and goes up to the higher grades. This has been a common practice almost among all the typical Muslim families in the cities to teach the Quran to a young child by a Muslim teacher called *Maulvi* or *Qari* Sahib in Pakistan. Selected portions of the holy Quran are the part of

the syllabus of all the government as well as the private schools throughout the country. The religious Maddrassahs (teaching institutions) even give much emphasis on detailed comprehension and understanding of the Quran. Dozens of verses can be quoted mentioning scientific or supra scientific explanations of the celestial objects, astronomy, and particularly the moon. Few of the translated verses are presented below:

What the Al-Qur'an says about moon; [Note: the digit before colon stands for the *Surah* number. (i.e., chapter in Quran) and the digit after the colon stands for *Ayat* number (i.e., verse number in that *Surah* of Quran)].

1. Crescent Moon and Sun as the standard to be used for reckoning of time:

> "They ask you about the waxing and waning phases of the crescent moons, say they are to mark fixed times for mankind and Hajj" (2:189).
>
> "And He who made the night for rest and sun and moon for reckoning of time. This is the decree of the Exalted, the All-knowing." (6:96).

2. Sun, moon, and the stars governed by laws:

> "Allah is He, who created the sun, the moon, and the stars (all) governed by laws under His commandment" (7:54).

3. Sun is source of light and Moon is just light:

> "It is He who made sun a lamp, and moon a light and measured stages so you know number of years and count (of time)" (10:5).

4. Sun and moon continue in an orbit to their destiny:

"Allah is He who raised heavens without pillars that you can see; Then He established Himself on the throne; And He subjected the sun and the moon (to his law); each one runs its course for a term appointed" (13:2).

"He has made subject to you, the night and the day; the sun and the moon; and the stars in subjection by His command" (16:12).

5. Orbits of celestial bodies:

"It is He who created the night and the day, and the sun and the moon; all (the celestial bodies) swim along, each in its orbit" (21:33).

"And the moon, we have measured for her mansions (to traverse) till she returns like the old, (withered, and curved-up like a sickle) date-palm. It is not permitted for sun to catch-up the moon, nor can the night outstrip the day; each swims along in (its own) orbit" (36:39-40).

6. Do not Prostrate to the Sun and Moon:

"Among His signs are the night and the day and the sun and moon. Prostrate not to the sun and the moon but prostrate to Allah Who created them if it is Him ye wish to serve" (41:37).

7. Signs of Qiyamah (Judgment Day):

"And the moon is buried in darkness. And the sun and moon are joined together" (75:8-9).

One of the important themes is that universe including the celestial objects of moon, sun, and day/night is created by Allah (God). Another important theme is related to the phases of the moon. Two important scientific realities, rotation and revolving in orbit and sun are the source of light whereas the moon is referred to as

the recipient of light. The moon has been exemplified as lamp. In summary, we conclude that several questions have been addressed regarding these objects, almost one thousand and four hundred years ago. None of these themes is contradictory to modern scientific realities.

Researches on Moon

Conceptual understandings and related alternative conceptions about the moon have interested researchers for more than 70 years (Trundle, Atwood, & Christopher, 2002). Investigating the ideas and understanding about the moon can help in different ways for teachers, students, and teaching and assessment for the long-term pedagogical implications. This natural phenomenon presents an exciting opportunity to integrate science and other subjects like mathematics in the middle school (Thompson & Harrell, 1997).

Every culture in the world has observed the phenomena of the moon, whether this is monthly cycle, religious rituals, or a yearly calendar for many diverse groups. Stories and misconceptions associated with the moon are unique for each culture. The fact that different cultures have different moon stories is easy to understand and it is appropriate to use a variety of these stories. The moon is an excellent subject for an at-home, parental-involvement activity. Moon observation provides an opportunity for children to learn science, make first hand observation of nature, and record and analyze data (Peter, Margarita, & Tracy, 2000).

Science education, because it deals directly with the natural world, plays a major role in shaping children's knowledge. In the classroom, children's knowledge

may sometimes be incompatible with scientific knowledge and scientific worldview (Lee, 1999). Therefore, students may come into science classes with their own ideas about the natural world. They likely have their own understanding about natural phenomena, such as why we have seasons, how traits are inherited from parents by offspring, and what causes moon phases, and may be why we have seasons (Trundle, Atwood, & Christopher, 2002). Misconceptions have been extensively investigated. Dai, and Capic's study (as cited in Laura, Gerald, & Danial, 1999) has shown that students' misconceptions often interfere with their learning of science.

Taylor (1996) believes that decades of science education research in United States, Australia, Britain, and New Zealand have amply demonstrated that many students hold non-scientific views about the phases of the Moon even after having been taught the scientific view. Rider (2002) also has stated that middle school students have many misconceptions about Earth's Moon, including profound difficulty in explaining the phenomenon of moon and why moon phases occur. This is true even of university graduates and teachers.

A little literature is available concerning the respective role of the individual and culture in the development of the child's ideas, because original data is seldom used in this discussion.

However, recently some researches have been conducted which can be ascribed as focusing on the related issues being addressed in the present research. Some important researchers are mentioned here.

Trundle, Atwood, and Christopher (2002) have conducted a study focusing on the conceptual understandings by pre-service elementary teachers about moon phases, before and after instructions. Results indicate that without the instruction, most pre-

service teachers were likely to hold alternative conceptions on the cause of moon phases. In another study conducted by the same authors, Trundle, Atwood, and Christopher (2006) indicated that prior to instruction most of the pre-service teachers had major deficiencies in the knowledge of observable moon phases and the pattern of monthly change in moon phases. Most recently, Bell and Trundle (2008) studied the conceptual understandings of 50 pre-service teachers about standard-based lunar concepts before and after inquiry-based instruction utilizing educational technology. The results indicated that before instruction none of the participants understood the cause of moon phases, and none were able to draw both scientific moon shapes and sequences.

Stahly, Krockover, and Shepardson (1999) have conducted a study to examine third-grade student's ideas about lunar phases prior to and following an instructional period designed to promote students' conceptual change. The results of this study indicated that students held individual views that were scientifically accurate; however, they also held conceptions that were scientifically inaccurate.

Abell, Martini, and George (2001) have investigated in a research about pre-service elementary teachers' conceptions of the nature of science during a moon investigation and concluded that scientific knowledge: (a) is empirically based; (b) involves the invention of explanations; and (c) is socially embedded. After conducting this study, they planned to include future instructions on the features that they will prompt to identify what they know about the moon and how they came to know it, distinguishing what one can come to know from: (a) observation alone; (b) invention; or (c) sources such as teachers and texts.

In USA, very recently, Kazemek, Louisell, and Wellik (2007) have conducted a research. In which they have examined how the child develops her understanding of the natural world through individual cognitive development as well as through the stories in which she finds herself imbedded through her culture. Their findings reflected the complex relationship of individual to culture in the child's construction of ideas.

Researches on Textbooks

Researches suggest that a child can be affected by many influences, from his/her parents, teachers, friends, TV shows, movies, commercials, and of course, books. Cohen and Lucas (1999) describe because the moon is probably one of the first objects to be studied thousands of years ago when astronomy was first being developed. In addition, this is one of the most common science topics taught throughout the world. Its constantly changing shape has lot of myths and every group of humans on earth has worked out the monthly cycle of the moon. This long-standing human interest in the moon has continued to the present.

Textbooks for children are widely recognized as having ideological, educational, socializing, and pedagogical implications and objectives. Therefore, this is important to understand that text produced and presented in the books. Because, the material produced for the very young children play an important role in (re)shaping discourses that are already in circulation in the broader social world (Saltmarsh, 2007).

Hill (1957) gave some reports from the research work of Beeler, which showed trends in the use of analogy in presenting science information to children through books and magazines.

Leal (1993) suggests that information embedded in a narrative format may be more memorable than information in a straight expository format. The greater retention of scientific information with the informational storybook may indicate that informational storybooks can be a useful tool to interest student in becoming scientific thinkers and readers.

Children's literature is likely to include misrepresentation of the Moon. Ault (1984b) identified the problems associated with the misrepresentation of the moon in children's literature and stated that alternative conceptions about the moon often originate from literature. Trundle, and Troland (2005) confirmed this when they evaluated 79 children's books that focused on the Moon as a topic or used the Moon prominently in illustrations; the results revealed that many books reinforce misconceptions about lunar phases and even misrepresent the Moon. So this is important to critically examine the textbooks, whether they are helping in better acquisition of the concepts or not. Students are considered as active knowledge generators who are capable of thinking critically and creatively. Then one should see whether, the curriculum and textbooks are providing such material, which is helping them in better understanding of the concepts. Researches show that if the students' linguistic and cultural backgrounds are represented in the curriculum and using culturally relevant texts can provide a crucial link between prior knowledge and reading comprehension (Alanis, 2007).

Learning science through listening or reading removes children from active involvement and makes abstract ideas difficult to comprehend. Elementary science textbooks that use pictures and diagrams of the Earth, sun, and moon system force readers to imagine that phenomenon from an outer space viewpoint (Foster, 1996).

Dorothy (1993) examined that whether text structure of informational storybooks as compared to an information book, influences comprehension of scientific information of the students. The results showed that information embedded in a narrative format may be more memorable than information in a straight expository format. These results are of great concern to the pedagogical and educational implications especially in the field of science education.

Statement of the Problem

The current status of education at primary level as discussed previously is detrimental for the future of Pakistan. This is the basic right of the children to have quality education, good food, better health facilities, better living conditions, and better attitudes from the society. The education system on the whole and particularly primary school education is in poor condition. The most affected part of this system is the children of Pakistan. The teaching and learning process is unable to gear understanding of knowledge, specifically science concepts.

A drastic change is required in terms of economic growth and better educational conditions, which are conducive to social and cultural environment. Psychology as science is the only field which can contribute more effectively to bring a positive change, particularly in the education of the children. Hence, the

responsibility of the psychologists is to come forward and accept the challenge posed to the children of Pakistan has increased manifolds. To meet such challenges (which have been enumerated in detail throughout this chapter), sound theoretical models are required, which are sufficient to gear a scientific study. Nevertheless, constructivist approaches are best suited for understanding the children's construction of knowledge. Multiple perspectives are required for a diversified and in-depth study regarding the children's construction of knowledge. For this purpose, the Piagetian, Vygotskian, and Bruner's approaches are fairly good frameworks for looking into the process of understanding and acquisition of knowledge.

Research involving children's understanding of scientific concepts has become more prevalent within educational communities. These types of researches involve identifying not only conceptions of the natural phenomena, but also the alternative concepts that exist among students at various ages. To investigate implications of children's understanding of the science concepts, one must have an understanding of how they develop their ideas and belief systems. In this chapter, a detailed account has been discussed about the constructivist theory. Constructive approach has been used to explore the understanding of the science concepts of the students in their cultural context.

Research Questions of the Study

More specifically, the study was undertaken to provide answers to the following questions:

1. What are the children's conceptions about the natural phenomenon of the moon?
2. In what ways are the primary school levels children's ideas about moon consistent or inconsistent with the scientifically accepted perspective?
3. Is there any cultural relevance in the formation of the children's concepts about the natural phenomena?
4. Can different dimensions of young children's natural science concepts be related to a broader framework of epistemological reasoning found in a specific culture?
5. Does a specific culture play any role in the acquisition of science concepts?
6. Does specific cultural artifacts in the forms of stories, for example, books, television programs, etc, have any contribution in the process of thinking?
7. Do individual children of different classes represent different scientific reasoning of natural phenomena of moon across the different stages of development?
8. Does the conception of the moon vary across the different developmental stages of the children?
9. What are the distinguishing features of scientific concepts naturally acquired by children taught to them through school curriculum?

The research questions guided the design of the study and the analysis of data. Questions 1, 2, and 3 are central to the study. As these questions, directly address the phenomena under study. Questions 4, 5 and 6 are related to cultural relevance to understanding or acquisition of science concepts. Question 7 and 8 is related to

psychological aspect of the study. Finally, question 9 is related to the analysis of the curriculum related texts. Qualitative analyses were used to address these research questions.

Chapter-II

METHOD

Selection of the Design

The understanding, knowledge, and interpretation of the children's ideas about natural phenomena of moon are constructed through various sources. The knowledge construction, according to psychological theories, can best be interpreted and analyzed by using and applying the constructivists approaches. The distinctive constructivist frameworks of Piaget, Vygotsky, and Bruner have been selected for this study. The selection of these theories as models for research on primary school children of Pakistan forestalled many alternatives of sampling, methodology, and research procedures. The contributions of Bruner, Vygotsky, and above all Piaget, have such strong integrated rudiments that their theory and method cannot be separated. Use of natural phenomenon to discover child's conception of physical causality has been widely used by him, more specifically, in his book 'Child's conception of physical causality' (Piaget & Valsiner, 2001). Continuing with the research traditions of these selected theoretical frameworks, foremost choice was left to go for a qualitative design of research for this study.

Sherman and Webb (1988) have identified five distinctive features shared by all qualitative research: (1) Events can be understood adequately only if they are seen in context (2) Nothing is predefined or taken for granted (3) Participants need to speak for themselves. For participants to be able to speak for themselves there is a need for an interactive process between the persons studied and the researcher (4) The aim of

qualitative research is to understand the whole experience (5) There is not one method and choices are made based on appropriateness.

Keeping in view the above characteristics and the very nature of the study, qualitative research traditions seemed most relevant for analysis and interpretation of the results. Through the use of qualitative method, in-depth, detailed data which captured the participants' personal perspectives could be collected without constraining them to predetermined categories or anticipated responses.

The qualitative design of this study involved *Case Study Methods*; in-depth interviews, observation of T.V programs, and document studies of textbooks and newspapers analyses. This work is conformed by Stake (1995) who asserted that when we speak of methods in case study, it means speaking principally of observation, interview, and document review.

An interpretivist framework was used to obtain the results. Consequently, two main levels of conceptual construction occurred in this study:

1. The first level involved interviews with the children, to explore the understanding of the natural phenomena of moon.
2. The second level consisted of attempts to interpret, observe, and content analyses to gain a better sense of the children's conceptions through the various sources of data. In this respect course books of classes I, III, V, and two national newspapers 'Jang' and 'Nawa-I-Waqat' (Urdu), of six months were analyzed as sources of science knowledge for the children.

Case Study

Multiple Case studies were conducted to get the results from these two levels of conceptual constructions. It would be interesting to know, what the ‘case’ itself is, and why we study it.

According to Stake (1995), a case is something special to be studied, a student, a classroom, a committee, or a program. Rather, not a problem but a relationship or a theme. The case to be studied probably has some problems. Moreover, it can be thought of as something that we don't sufficiently understand and want to study; therefore, we do a case study. Stake further suggests that a case is studied when it is of very special interest on its own and we aspire to know for detail of interaction with its contexts. This is the study of the particularity and complexity of a single case that come along to understand its activity within important circumstances.

Issues and Case Studies

To carry out a study of the case, it is needed to organize the data gathering and reporting. It is often beneficial to organize the study around issues. Issues are problems about which people disagree, complicated problems within situations and contexts. Choosing issues helps in defining data sources and data gathering activities. Most of the time, we have to make observations, to conduct interviews to get observations of things we cannot see ourselves, and to review documents for a detailed comprehensive and in-depth study. Doing these things will usually cause us to reconsider our issues. Certain new issues will emerge. Case study work is often

said to be "progressively focused," i.e., the organizing concepts change somewhat as the study moves along.

Often this is important to look for multiple perspectives of activities and issues, to discover, interpret, and portray different views. For this purpose, the cases are observed in their ordinary activities and places. It have been tried that intrusion be minimized, while avoiding special tests and assignments characteristic of survey and laboratory study. Although, it is recognized that case study is subjective, relying heavily on the previous experience and sense of worth of things. Anyhow, the approach is used to let the reader know something of the personal experience of gathering the data. And such techniques has been used as minimize misperception and invalidity of conclusions. An accurate though limited understanding is tried to look for. Very rarely, it is primarily to generalize about other cases. Still, some comparisons with other cases are inevitable. However, previous generalizations are often modified somewhat as a result of acquaintance with a new case (Stake, 1995).

The Issues of Class or Grade, Age, and Gender

Class or grade. 'Class' represents the same meaning, as what would be meant for 'grade' in American educational institutions. So, this is a synonymous word for grade used for government run educational institutions in Pakistan. Therefore, the word class has been used throughout in this manuscript.

Classes I, III, and V were taken as units of case studies for the present research, skipping classes II and IV. Taking all the five classes would not have been of much interest, reason being, to avoid overlapping of the results.

A psychological study implying diversified areas of cognitive, socio-cultural, and educational perspectives within the broader field of psychology demanded an in-depth and comprehensive study. Hence, three classes were taken for a more detailed study to see the differences in terms of psychologically, socially-culturally, developmentally, and educationally important issues.

Ages of the children. The children were studying in I, III, and V classes. Normally a child in Pakistan is enrolled in the class I, at the age of five and above. After one year of complete studies and successfully passing the specific class, the child is promoted into the next class. That means a child in class one would be of five or six years, and in class III; seven or eight, and in class V, the child would be of nine or ten years old. Seemingly, this age group and class levels are developmentally and psychologically appropriate for this particular study. This general age range of the children truly corresponded to the Piagetian ego centric period of development, when most of the children can demonstrate cognitive tendencies of thoughts such as *animism* and *artificialism* (Louisell, Kazemek, & Wellik, 2007). Moreover, according to Piagetian developmental stages, the children are in pre-operational and concrete-operational stages, when the majority of the children would be studying in primary schools in classes I to V.

It was considered important to base this research on the class levels, instead of age factors as the variables. The reason is that, this study is not being conducted under the tight control of demographic, social, psychological variables on experimental basis. However, the data were interpreted and analyzed on the basis of exploratory methods to make inferences and generalizations using the qualitative methods.

Gender. Within the science education research, the issue of gender has been widely studied during the last few years. Baker (as cited in Brotman & Moore, 2008) described that 1990's was the "breakthrough in terms of the official recognition that gender is a crucial issue in science education" (p. 661). Considering that it was decided to study the participants included both girls and boys equally. The gender of the child and each child's general level of academic background was taken into consideration to see the differences among these issues, whether this had any impact on the phenomena under study.

Research Settings

This study was conducted in the federal government primary schools of the city of Islamabad; the capital of Pakistan. Geographically, it is the starting point of Northern Pakistan. From the south, largest province, 'Punjab' of the country surrounds it. Other side links with 'Khyber PakhtoonKhaw' (formerly North West Frontier Province). In addition, from the upper North, the state of 'Azad (independent) Kashmir' touches it with high mountains. One of the biggest cities of Pakistan; Rawalpindi, is adjacent to the capital, they are often called 'twin cities'. Culturally, Islamabad is the most modern city, a blend of industrial Western and traditional Pakistani cultures. Its cultural and social life is unique combination of all the sub-cultural groups of the nation. This distinctive characteristic makes this city ideal for a psychological study.

Selection of the Schools

The children belonged to six different government schools of Islamabad. These schools ranged from Islamabad Colleges for Girls (ICG), Islamabad Model Colleges for Girls (IMCG), Federal Government (FG) Model Schools, and Federal Government (FG) Schools. These schools represent all types of government schools at federal level, as there are different types of educational institutions throughout the country including private schools. These schools are located in different areas of the capital area, for example, model schools and FG schools are situated in the suburbs (villages) of the main metropolitan city area of the capital. On the contrary, ICGs and IMCGs, are located in the city area. Therefore, they represent the diversified social, economic, and educational backgrounds of the population.

The schools were chosen on the basis of their locality and standard, because, some schools are highly ranked due to their academic standards. Those schools, which are situated in the middle of the capital, sometimes, they represent the locality of high social class. Different schools settings were selected to see any affect on the knowledge construction and acquisition of the children. These schools were selected on convenience basis, such schools were easy to approach and the school administration showed interest in carrying out this study.

Private schools were not considered for the study, due to altogether different school settings, social set up, and a different system of education. Moreover, the children, written material including textbooks, teaching standard would have been so different with the rest of population which would have seriously undermine the whole study otherwise.

Participants and Sample

Interviews are usually very time-consuming to conduct and to analyze, therefore, many interview studies have been based on small samples (Bell, Brook, & Driver, 1985). Hence, the sample of the present study consisted of 3 in the try out, 10 in the pilot, and 24 in the main study respectively. During the process of data collection in the main study, two children were dropped due to the reasons of their unwillingness to carry out the interviews and were replaced by other willing children. The names of the children appeared in this manuscript are fictitious to maintain the secrecy of the children. The details will be mentioned in upcoming sections of different phases of the study.

Qualitative research which stresses in-depth investigation in a small number of participants as in this present research uses purposive sampling as opposed to random sampling (Bowen, 2005), because the primary objectives of such types of researches is to see the phenomenon qualitatively. Therefore, purposive sampling technique was used in this study. The purpose was not to increase the numbers but to get useful and productive data on the topic. To conduct any psychological study, certain criteria should meet the requirements to complete the study successfully; this sample size sufficiently fulfilled the criterion of *manageability* in terms of the number of schools to be visited, *accessibility* of the children which are obviously the students of those schools, and *willingness* of the participants (children) to speak freely with the researcher.

Data Sources

Data were gathered from multiple sources including any related contexts. For example children, parents, teachers, mass media (televisions programs related to the children), and artifacts (critical examinations of textbooks that the children themselves had read), and newspapers were taken into consideration. However, interviews with teachers, and parents were conducted only at the try out phase. Since the research failed to provide any tangible contextual information and data related to this topic was dropped.

Finally, the main data and results depended upon extensive interviews with the children and textbooks analyses, which added contextual information to the overall data set, as well as provided opportunities for triangulation during analysis.

Trustworthiness. The major concern with the qualitative research has been the issue of standard, so, this was kept always in mind to provide proper checks and balances to maintain acceptable standards of scientific inquiry. As it was mentioned in the beginning of this chapter that interpretivist framework was used in terms of trustworthiness as opposed to conventional, positivistic criteria of internal and external validity, reliability, and objectivity (Denzin & Lincoln, 1994; Lincoln & Guba, 1985; Padgett, 1998).

In this present work following strategies were adopted for a minimum balance: emphasis was put on *triangulation* and employing *member check* methods for tapping different sources of data.

Member checking. Member checking was involved at each critical stage of the study to safe-guard the accuracy of facts and observation. It started from data collection and continued up to data analysis. Crosschecking helped in maintaining reflexivity by encouraging self-awareness and self-correction. The details will be mentioned in the results and analysis sections in the next chapter.

Triangulation. As it is mentioned, in case study work, to achieve accuracy and alternative explanations, protocols are needed, that do not depend on mere intuition and good intention to get comprehensive and accurate description of issues. In qualitative research, those protocols come under the name of 'triangulation'.

In the present research different strategies were employed to get the data and draw inferences. However, main thrust was on triangulation; various methods were employed and data were tapped through different sources.

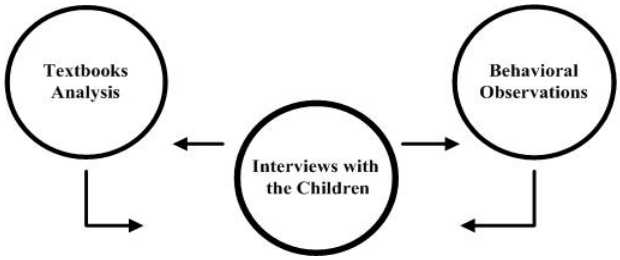


Figure 1. Triangulation strategies

(Note: The Critical Method used in this study covers both Interviews with the Children and Behavioral Observations).

Triangulation protocols. The researcher can use different and several types of protocols, to get the needed confirmation, to establish the credence in the interpretation, and to demonstrate the commonality of an assertion.

Interview protocol. Much of what one cannot observe for himself has been or is being observed by others. So, here, two basic uses of case study are to obtain the descriptions and interpretations of others. Consequently, the case will not be seen the same by everyone. Qualitative researchers take pride in discovering and portraying the multiple views of the case. According to Stake (1995), the interview is the main road to such multiple realities and views.

Interview Schedule as an Instrument

Different types of 'interviews' are used in psychological researches for identification of the problems, exploration of the variables, and gathering data for a variety of purposes. The selection of the theoretical perspectives for this study left no choice using other than in-depth interview protocol for data gathering. Because, the in-depth interview approach is ideally suited to explore motivation, morality, spirituality and social awareness as these appear in the past and present subjective experience and consciousness of the individual, forming part of the individual's self-understanding and world-view (Wits, Goodwin, Hart, & Thomas, 2001; Wits, 2006). In this study, an attempt was made through in-depth interview schedule as to how children come to understand the natural world according to the cognitive structures and mental tendencies of thought in which they find themselves embedded through their particular culture. For this purpose, it was required to use such type of interview schedule, which was based on Piagetian, Vygotskian, and Bruner's theoretical assumptions and research traditions. That should be culturally free and could be easily used on the primary school children of Pakistan for extensive and complex exploration of their thinking.

Nevertheless, the opportunity was there to use a similar, but exactly competing the requirements of the present study, interview schedule developed and conducted by Kazemek, Louisell, and Wellik (2007) in their study of '*Children's stories about their natural worlds: An exploration from multiple perspective'*, that best suited for this particular study. In developing the interview schedule, they have used approach recommended by Piaget (1975), and Denis-Pronghorn and Grize (1976). This interview schedule for the children has been developed on the basis of Piaget's questions about the origins of the moon in *The Child's Conception of the World* (1975). This interview protocol was originally developed in the United States and was first administered to the American children.

Before we take a look at the interview schedule, it seems appropriate to give a description of clinical method as developed by Piaget over a longer period of time. It would be appropriate to point out here that the Critical Method, discussed below, is an amalgamation of interview and observation. Therefore, in the Triangulation protocols, illustrated at Figure 1, the Critical Method covers both the Interviews with children and Behavioral Observations.

Critical Method

The available clinical method to psychologists is the most flexible one as compared to other available interviews carrying psychometric properties for assessing the behaviors and personality, etc. It is the combination of observation and experiment. Its way of investigation consists of a dialogue, speech or conversation, essentially in the form of questioning taking place between two persons: the interviewer and the respondent; generally the interviewer represented by an adult, and

a respondent usually by a child. It servers the main purpose of exploring the child's thinking processes. It is conducted in a dyadic situation carrying individual sessions. Irrespective of the situation, whether doing purely verbal situations or whether the child is asked to act on concrete material, the purpose of this dialogue remains the same: such questions are posed that permit following the thought of the child and inhibits her for getting lost. During this process the effort is done to explore the child's thoughts in order to determine what sort of mental processes are taking place and what are underlying thought patterns in the different responses of the child.

In short, critical method is referred to as 'discovery approach'; the adult makes a serious effort to explore the child's thinking, thus discovering the inner thoughts allowing a great deal of flexibility in this discovery approach.

Critical method has some important features, if properly followed, will help in identifying deep down thought processes. Keeping in mind these features, the whole process of taking interviews was carried out with the children.

Building rapport. The interviewer should not start actual interview until the child is relaxed mentally and psychologically prepared for a conversation.

An authoritarian nature of relationship exists between the teachers and children in the schools in Pakistan, so it was necessary to reduce it at minimum level. An attempt was made to be compatible with the level of children while interacting with them. It was considered as a rule to sit along with the children, which is a rare phenomenon between teacher and child in a typical Pakistani context.

The interviewer starts asking questions about his family members, personal interests of the child, favorite courses of studies, the games a child likes to play, etc. An interviewer should not ask deep down questions right in the beginning, instead, at

first he should win the attention and concentration of the child. For this purpose he/she can give some toys, candies, or pencils to get familiar with the interviewer, thus gradually preparing the child to answer in a best way.

Language of the child. The interviewer should be aware of the typical language pattern, phrases a child may use, particular words he chooses to answer, etc. The interviewer should try to understand the child's responses within his frame of reference. He should try to comprehend the things from a child's angle. He should view the responses from the child's view and acknowledge his level of understanding.

Motivation of the child. The interviewer must be aware of the child's level of motivation. There are chances that child may lose his motivation due to his anxious state, or feelings of threat in front of a person, who is not known to him much. He may feel shy, he may not talk freely, sometimes he may sit quietly, answering in a very low voice, or may be just nodding or answering in 'yes' or 'no' fashion. Even worst situation can happen on the part of child, he may be totally unwilling to give interview. This type of situation should be avoided, and there is no need to continue the interview any more.

The levels of excitement of the children may change during the interview process, for example, the child may show a high level of interest in the beginning and may be lowered in the middle. Therefore, an interviewer must be aware of these changes, and act accordingly, because, this is not a testing or examination situation, so, he should try that child is not taking it like this. Rather, the 'child' is supposed to talk freely and he is encouraged to keep his level of motivation high.

Tone of the interviewer. Tone of the interviewer plays an important role in keeping the motivation high of the child. Harsh and rough tone may distract the concentration of the child. It may discomfort the child in giving the proper responses. Child may feel threatened and scared of the situation, and he may not be willing to cooperate. Consequently, it may bring a great damage and disastrous effects upon the whole essence of the interview.

Tempo and pace of the interview. There should be perfect balance in terms of tempo and pace of the interview. A tempo should be maintained in accordance with the responses of the child. Younger children may take little longer time to respond, because they have to think and organize their answers. So, the interviewer should pay full attention to the children, and listens whatever the child says. This will encourage the child to talk freely and feel relaxed and confident.

Tapping genuine responses. Sometime, the children repeat and reiterate the same responses for nothing. The interviewer must be aware of such responses; he must try to distinguish between genuine responses reflecting the true understanding of the child about the question posed to him. The interviewer must avoid passing conflicting remarks about the style of the child. As a matter of fact there are no 'true' or 'false' answers in clinical method. Therefore, an interviewer must be careful in judging the right answers. He should be extra conscious of analyzing the child answers, implicit or explicit response patterns, bizarre behavioral patterns, physical gestures and movements of the child. All such things reflect a particular meaning on the behalf of the child.

Probing. Probing is a key characteristics of this interview technique. This is specially designed to clarify the child's responses. Every answer is prompted with a new question. This process is allowed to continue until the researcher feels that he is satisfied with the information provided by the child.

Inquiry into reasons. One of the chief characteristics of the clinical method is that the child is suggested to provide justification for his answers. This is done by asking a 'why', 'what', or 'how' sort of questions. For example, the interviewer may ask in a response of a particular question, why that happened, how do you know that, or what else do you know about this phenomenon? But there are chances that a child may feel hesitant and threatened fearing that his answers might be incorrect. So, a special care must be taken while asking such types of questions.

Counter-suggestions. In the above-mentioned situation when the child is unable to provide a reason for his answer, the interviewer may give a child counter suggestions.

The clinical method is associated with one of very delicate practice. The role of the interviewer is very important and sensitive, and some time certain people find themselves becoming troubled about it. Only high level of professional skills by a person is expected. Who can control his emotions, passions, his personal biases, and can exhibit extreme level of intellectual honesty.

Few factors may influence the interviewing situation, the interviewer must be aware of such factors. The interviewer may commit three common types of blunders: (1) the response of the child may be influenced by the attitude of the interviewer. (2)

A response may be fortuitous due to uncontrollable phenomena. (3) It is difficult to prevent responses containing meanings for the child and the one who questions him.

The interviewer can overcome these mistakes by following such steps: (1) to insist a child to justify the responses he gave, (2) to introduce counter-suggestions (3), the child's predictions may be verified with reference to the situation.

Abiding by such precautions can bring fine results obtained by the clinical method.

Procedure

Some basic procedures were adopted overall to carry out the whole process of entire research. However, some specific procedures were also employed for each phase and step of the study. The details will be presented in each particular study in the coming sections.

Training of the Researcher

Since present study was heavily dependent on clinical method/interview that served as main source of data gathering tool. Therefore, it was thought important to have a prior practice of conducting interviews with the children to get a better grip and control over the critical issues.

In this regard, after the extensive reading of the literature related to clinical method, several sessions were arranged with the advisor. Multiple pseudo rehearsals were carried out, to get a practical insight and confidence, regarding controlling the emotions, pauses, listening, clues, voice, language, content area of the topic

concerned etc. Before going into the schools for data collection, several practice sessions were performed until a reasonably good command was acquired in handling and dealing with the children.

The researcher approached the targeted schools with the permission of the school administration. A prior consent was obtained from the head of the school as well as the class teacher. Each of the children was interviewed individually. These children were selected at random from their respective classes to ensure the balancing effects. The class teacher was asked not to recommend only 'good' and 'bright' children, as this type of interview was not meant to check the academic performance of the child. To avoid this situation, the researcher went personally in the desired class, and selected a child for interview by himself. The researcher had to get along with the class teacher, to ensure the rapport, which is a prerequisite for an in-depth interview.

Establishing Rapport

The researcher and the child sat in a quiet room or place. Where, no one else could interfere or disturb the interview process. Such a place would be arranged by the school administration. Once the child and researcher were settled down, gradually the interview session would start. Normally, it started with introductory questions, by asking what was the name of the child and his father, what was his father, in which class he/she was studying, what was the favorite game of the child, what type of food she liked most, and what was the name of the school, etc. Such types of questions were carried on, until the researcher felt that the child was ready to listen and answer

the research questions and a rapport has been established with the child. Through this way, the researcher would lead the child to actual research questions.

Follow-up questions were used throughout the interview to clarify ambiguous responses and it was tried to obtain accurate picture of children's responses as much as possible. There was no time limit for the interview. However, young children could get a little longer as compared to the elder ones. Most of the children chose to answer in Urdu, irrespective of the difference in mother tongue of the child. However, sometimes especially in rural area schools, younger children would shift their responses from Urdu into their mother tongue. Each child's responses were recorded on audio recorder for later transcription and analysis.

Probing

The individual participants responded to the interview questions based on clinical method, the interviewer probed for deeper explanations until no new information seemed to come from the responses. The interview was treated like a conversation is going on between the interviewer and respondent. Through this informal conversation the interviewer tried to draw out detailed information from the respondents while maintaining a relatively high degree of flexibility.

When using the oral data, the researcher must construct for himself, a meaning of the language of the children, and there must be a considerable overlap between the constructions of the children and those the researcher is imposing on the data (Bell, Brook, & Driver, 1985). Verbal explanations provided richer data about the children's understanding of the natural phenomena of moon. The advantage of being able to probe a verbal explanation during an individual interview looked obvious.

Interviews of the children also provided rich, detailed data that captured participants' personal perspectives without constraining their responses to predetermined categories or anticipated responses. Data analysis identified patterns and themes in the children's conceptual understandings of phenomena of moon. Analysis also included organizing the data and searching for patterns to describe children's conceptual understanding about the phenomena under study.

Translation of the Interview Schedule

The interview schedule developed by Kazemek, Louisell, and Wellik (2007) as it was mentioned earlier in the chapter I, was translated in Urdu and used for data collection to explore the children's understanding of the natural phenomena of the moon in current study.

Member checking. Committee approach was adopted for the translation of the interview schedule. Two psychologists who were also teaching faculty at the National Institute of Psychology, Quaid-i-Azam University, Islamabad, Pakistan, along with the main researcher rendered their services in the translation process. Then it was presented to the advisor for final approval. The advisor was satisfied with the translation and allowed to use it in the field for data collection purpose.

Three parts of the interview schedule. Basically, it had three sections; each of the three sections in the schedule addressed both children's knowledge and understanding of the moon. The intent was to probe from the children about their knowledge. The questions were originally asked in an interview to a sample of

children studying in primary schools. This interview schedule was the first level of data collection. Each question was listed in such a manner that seemed likely to occur. To volunteer an idea of a child about an issue, less direct questions were listed first to ask. In case the child's ideas were not coming out, then direct questions were asked. Through this way, the children's knowledge and ideas about moon were explored. This interview schedule included questions about the location of moon in the sky, its rotation and movement, phases, living or non-living object, disappearance, and to tell a story about the moon. The effort was done to obtain as much information as possible about the children's underlying concepts rather than about the information they may have memorized in a superficial way. An example of this type of question is "Is the moon alive? How do you know?" Children could answer this question correctly by simply repeating information they had obtained from adults without having necessarily incorporated this information into their conceptual framework.

Second part of the interview schedule related to the children's constructions of stories. In this portion of the interview, the starting question would be to ask the child, "Can you tell me a story about the moon?" or may be like this, "Tell me about the story of moon". Normally the younger children may not know how to tell a story. In this case, some tips would be offered to help the interview process.

Third and final part of the interview focuses on the parents. It was tried to involve and get information from the parents, especially mothers of the children, because, supposedly younger children are more associated with the mothers. Initial attempts could prove to be helpful, this was felt that the mothers were unable to comprehend and respond the questions. This may be due to the reason that in a typical Muslim society, if not is possible, it is definitely very difficult to interact with any stranger women in an interview like situation. Social customs and taboos may hinder

to seek consent and willingness for such type of interactions. In a way, this segment of the interview schedule proved to be ineffective in Pakistani context.

Nevertheless, this was done only in the piloting of this study. Then the researcher founded not to include this portion in the main study, as this was not of much help. It did not prove to be useful in collecting the data.

Data Collection

The primary data collection method was in-depth interview schedule which has been mentioned in detail in the previous sections.

Additional data collection methods were behavioral observation and cognitive mode of the thinking of the child and critical examination of the curriculum related textbooks of the children along with the examination of hard-copy issues of 'children page' of the newspapers.

Transcription of the interview protocol. Each audio taped interview was transcribed first in Urdu and then was translated into English. English translation is done for the international audiences. After interviews were completed, systematic content analysis identified themes pertaining to understandings of the moon concepts among the children. A list of participant statements was generated. One list included responses describing common confusions, misunderstandings or misconceptions related to the phenomena of the moon. The statements from each interview were sorted according to their main message. The interview process with most of the children was completed in about 20-30 minutes.

Analysis of the Interviews

The analysis of interview transcripts was based on an inductive approach geared to identifying patterns in the data by means of thematic codes. Inductive analyses are those patterns, themes, and categories of analysis which come from the data. They come out of the data rather than being imposed on them prior to data collection and analysis (Patton, 1980).

Iterative process. Data were analyzed by using the iterative process; through this process initial analyses were followed by several cycles of additional data collection and more analyses. The lines, sentences, and paragraph segments of the transcribed interviews were reviewed to decide what codes fit the concept suggested by the data. Since, this study heavily depended upon the interviews, the interview data were given more weight in the analyses. Each code was constantly compared to all other codes to identify similarities, differences, and general patterns.

Coding scheme. The data analyses systems and techniques used in this study were taken from the previous researchers conducted regarding moon studies for analysis by Bell and Trundle (2008) to identify criteria to describe a scientific understanding and possible alternative conceptions participants might have. In the current study, the researcher has used similar coding system for each interview. Coding schemes have been used to assess the scientific views of the children's understanding of the phenomena of the moon (for details please see the result section).

Understanding of science concepts in cultural context is a new field of research in Pakistan. Probably this is the first kind of study, in terms of scope and

method in Pakistan. So, it was considered important to carry out this study into different stages and phases, to explore children's natural world and obtain basic understanding of the use of cultural artifacts in the process of knowledge construction.

Design of the Study

Two studies were completed to find out the answers of the research questions. Study 1, was completed in three different phases. In the phase first, a try out study was conducted to check the appropriateness of the interview schedule, which was initially developed in United States of America. In the phase two, to analyze the contents of the interview protocol (verbatim), a pilot study was carried out. And in the phase third, a critical analysis of the course books was done, to examine the contents of the science concepts. The findings of the Study 1, helped in the conceptualization of the Study 2, which is also the main study. Study 2 was completed in a single phase. All these studies helped in understanding the phenomena of the moon through a cultural context by the children.

Study 1

Phase 1: Try out

Objectives of the study. The try out study was carried out to:

(a) Asses the suitability of the translated and adapted interview protocol for a broad based study,

(b) Have an insight into the different themes of children's understanding of moon's concepts, and,

(c) Identify the prospective sources of future directions of the study.

Method. Clinical interviews were conducted with the children, using the translated version of interview protocol initially developed by Kazemek, Louisell, and Werrik (2007). The Easley's (1974) approach of structural analysis of protocols and Stake's (1995) analysis for case studies along with thematic approach was used for data analyses.

Sample. Muniba, Khoala, and Waqar Shah were three Pakistani children studying in three different schools of the capital area of Pakistan. These children were studying in the class I, III, and V respectively. Muniba and Khoala were the female students, whereas, Waqar Shah was a boy. They were living in the same residential area of the researcher.

Procedure. Muniba's father was a newspaper hawker and Khoala's father was a primary school teacher, whereas, the father of Waqar Shah was a government official in Islamabad. These children were contacted through their fathers. A prior consent was granted from them for an interview. Typical social and cultural customs do not allow sitting and talking with the children in isolation, especially with the girls. Similarly, social and cultural taboos strictly prohibit talking with the females of a family, unless not being a close relative or a very close family friend. All the interviews were conducted in the sitting room of the researcher.

As this has been mentioned earlier that the researcher felt difficulty in conducting follow up interviews with the mothers of the children; they could not be interviewed due to typical social and cultural constraints, because, in a typical Muslim

society, an open interaction with the adult females with the unknown males is normally difficult. However, follow up interviews were tried to conduct with the fathers of the children. But this proved to be a futile exercise, as interviewing only with the fathers was not encouraging and helpful in gaining useful information regarding the moon concepts of the children.

Each interview was audio tapped and transcribed for later analyses. While analyzing the data, a careful attention was paid to possible cultural influences that a child may have in her process of thinking and that might have contributed in child's understanding and vision of the moon, for example, every day concepts, such as books, stories, siblings, adults, teachers, friends, media, and other environmental factors.

Phase2

Step 1: The pilot study. In the first step, the pilot study was completed.

Objectives of the study. (a) Main purpose of this pilot study was to analyze the contents of the interview protocol; interviews with the children, parents, and teachers (verbatim), and observation of T.V programs to identify the possible sources of children's concepts of the moon.

(b) To formulate coding schemes for the analyses and interpretation of the interview protocol.

(c) Identify and checking out the appropriateness of the categories of responses emerged out of the questions asked to the children.

Method. To address the research questions posed earlier in chapter one, four related investigations were completed. (a) Interviews were conducted with children belonging from different schools and classes. (b) Interviews with the parents were carried out to see whether they contribute in the understanding of the natural phenomena. (c) Similarly, teachers were also interviewed to see as to what extent they are contributing in the understanding of the phenomena under study. (d) Children specific T.V programs were also observed to see how they are helping in the understanding of the natural phenomena of the moon particularly.

So, it was decided to interview with the few parents and teachers to get a better picture of the whole process of thinking in a constructivist approach. Moreover, it was also decided to observe the children specific T.V programs of Pakistan Television (Ptv), which is the official channel.

Consequently, three levels of conceptual construction arrived at in this pilot study. The first level involved the children's ideas and understanding about the phenomena of the moon. The second level consisted of an attempt to understand the respective role of the parents and teachers in the understanding of the science concepts of the children. Level third was an attempt to seek the role of the T.V programs in the understanding of the science concepts, particularly the concept of the moon.

Sample. The sample of this study consisted of 10 children including both girls (6) and boys (4). They were studying in first, third, and five classes, at different schools in the capital (Islamabad) of Pakistan. These schools were situated in different areas from metropolitan to typical suburb areas. The gender of the student and each students' general level of academic background was taken into consideration

to see the differences among them, whether they can affect the phenomena under study. A qualitative investigation was carried out to address the research questions. A Piagetian interview schedule was conducted with the children to get the results.

Procedure. This was tried to gather data from multiple sources including any related contexts. For example, interviews with the fathers, teachers, and observation of T.V programs were taken into consideration. Final analysis rested on the interviews with the children. Extensive interviews were recorded on each visit.

Step II: Interviews with the parents and teachers. Three school teachers and three fathers were interviewed. However, Interviews with them could not add much help in providing the information. They seemed least bothered and concerned with the issue. Therefore, it was decided not to take more interviews from parents and teachers, as it was also reflected by the results of try out study as well that the parents and teachers are contributing little in the concept formation of the moon.

Step III: Brief observations of the T.V programs. Those children who have the opportunity to watch the programs related to natural phenomena on T.V., may understand and learn better as compared to those who do not. Previous research done by Smith (1964) showed that watching T.V can help in explaining the natural phenomena. The results showed that those children have access to television in their homes had a favorable effect on explanations of natural phenomena.

Considering that, it was decided to observe the children related shows presented on Pakistan Television, were briefly observed to see the contents of the programs.

Pakistan Television is the only official channel in the country. According to sources, more than 70 percent population has the access of watching this channel among the T.V. viewers. Due to this vast networking and viewership, it was decided to include those T.V. programs which are meant for children as the main evidence. Such related programs included music, information, educational, cartoons, entertainment, and religious etc. The intention was to observe and sort the contents of such programs containing the science knowledge of moon concepts. The observation was carried out for 10 weeks, from February-April 2005. One of the research assistant also helped in observation of the T.V. programs. The researchers used to observe almost 2-4 hours daily in the afternoon till the evening (around 3:00 PM to 6:00 PM), because this is the primetime in which programs related to children are shown on the national network.

The researchers could not find any specific program which contained substantial elements and support of explaining the phenomenon of the moon. None of programs depicted, narrated or showed any contents helpful in contributing the understanding of the science concepts. So, it was decided to relinquish from the observation of the T.V programs, as the data was not available.

Therefore, the primary source of the data was the audio taped interviews with the children.

Step IV: Interview analysis. The data analyses systems and techniques used in this study were taken from the previous researchers conducted regarding moon studies for analysis by Bell and Trundle (2008) to identify criteria to describe a scientific understanding and possible alternative conceptions participants might have. In the current study, the researcher has used similar coding system for each interview.

Coding schemes have been used to assess the scientific views of the children's understanding of the phenomena of the moon.

Apart from the coding schemes an iterative process involving on-going analysis was employed in this study: interesting findings that emerged from examination of each interview transcript were taken into consideration. From this process, several themes mentioned by interviewees were identified in the data analyses. So, these interviews yielded a range of themes related to the understanding of the scientific concepts of the moon. This analysis technique has been used by Naughton, Schreck, and Heikkinen (2008). They have interviewed with representatives of nine municipal agencies involved in air-quality education and analyzed the interviews for concepts and skills perceived as important for citizens in addressing air-quality concerns. These two analysis techniques are best suited for this particular study.

Each audio taped interview was transcribed first in Urdu and then was translated into English. English translation is done for the international audiences. After interviews were completed, systematic content analysis identified themes pertaining to understandings of the moon concepts among the children. A list of participant statements was generated. One list included responses describing common confusions, misunderstandings or misconceptions related to the phenomena of the moon. The statements from each interview were sorted according to their main message.

Member check. Following detailed content analysis, comprehensive examination of individual interview transcripts by a group of three experts including

the main investigator, determined which themes were highlighted within each interview.

Subsequent to their independent analysis of the transcripts for themes, experts met to discuss their findings. All the categories and themes are summarized in Table 5.

Phase 3

Step I: Newspapers analyses. Norris and Philips asserted (as cited in Ford, 2006) that the important resources for children to access the science knowledge and facts are through books (textbooks analyses will be described later in the coming sections) and their nonfiction equivalents, including newspapers and television that most people get their scientific information (it has already been discussed).

So, it was thought that newspapers may have contents related to science knowledge. To check these possibility content analyses of the newspapers as sources of science knowledge was conducted.

Objective of the study. It was one of the goals of the study to examine the text structure and content about the science concepts presented in the newspapers to determine if the text presented in any form is helpful in the children's understanding of the science concepts. The study examined the different modes of representation of the textual material in the newspapers.

Method. The literature suggested that content analysis can be the best way to examine the text material related to science concepts, presented in the newspapers,

regarding the science concepts. One of the major functions of the text material whether in the form of books and magazines or newspapers etc, is to present the concepts for the transmission of knowledge to children and adults. Studies show that psychological tools such as newspapers, magazine, and books help in the shaping of concepts. Children learn about the concepts particularly science concepts through different sources. These concepts are presented in different styles and shapes, may be in the forms of narration, story, examples, illustrations, figures, pictures, diagrams, and analogies, etc. This has also been supported by Hill (1957), who gave some reports from the research work of Beeler, which showed trends in the use of analogy in presenting science information to children through books and magazines.

Procedure. The daily 'Jang' and 'Nawa-I-Waqat' are two popular newspapers in Pakistan, which are published in Urdu language. These two national dailies are widely read in all the sections of the society across the country. This is claimed that 'Jang' has got the highest circulation in the world among the Urdu dailies.

According to a survey around 70 percent of the population is reader of these two national dailies in the country. These two dailies issue the children edition once in a week on regular basis. This children's page has got the popularity among the Pakistani children. This has been observed that school going children take very keen interest in the reading of this particular page.

Therefore, it was decided to analyze the newspapers containing as sources of science knowledge. Therefore, these two Urdu national dailies ‘Jang’ and ‘Nawa-i-Waqt’, of six months, from October 2005 to March 2006, have been analyzed.

For the analysis of the newspapers, the relevant section of the library of National Institute of Psychology, Quaid-I-Azam University was contacted. The

newspapers were collected from the beginning of the first week of the month of October 2005 up to the end of March 2006.

After scanning all the pages, the printed information was categorized basically into two frames**.** One can be called *main frame* (MF). This MF consisted of eight areas of information in the complete page. The other can be called the sub-area of the MF, that having the actual content, substance or material in the MF. This sub-area can be called *small frame* (SM).

Member check. To avoid the subjectivity, which is certainly the main drawback of this kind of qualitative analysis, was controlled by having cross checking by three analysts. These experts were the university teachers and researchers in the field of psychology. The formulated categories of MFs and SMs were discussed with those experts and their valuable suggestions were incorporated in the results.

All the categories of frames are summarized in figures 5 and 6, in the results section.

Step II: Textbooks analysis. Textbooks for children are widely recognized as having ideological, educational, socializing, and pedagogical implications and objectives. Therefore, this is important to understand text produced and presented in the textbooks. According to Saltmarsh (2007) the material produced for the very young children play an important role in (re)shaping discoursed that are already in circulation in the broader social world. So, this was also considered imperative to analyze the textbooks used in primary schools for classes; I, III, & V, to get a clearer picture of presented science concepts. Therefore, the course books of class I, III, and V has been analyzed, considering having sources of scientific knowledge in them.

Objectives of the study. How do course books portray science concepts? To what extent do the books meet aims and goals for better understanding, broadening and deepening children's conceptions of the science?

More specifically the analyses of the textbooks were done to find out to which extent:

(a) The implicit and explicit science concepts are instantiated that help in the better understanding of the science concepts of the children.

(b) The space and volume is given to the science concepts in the textbooks.

(c) The forms and modalities through which these concepts have been presented.

(d) The illustrations and pictures have been used to present the concepts.

Method. The course books were selected and analyzed for their representations of science concepts using a content analysis methodology. The selection of the sample of books used for analysis, the units of analysis and coding scheme and its development will be discussed in this section.

Sample. The textbooks analyzed in this study were chosen on the basis of the criterion that these books were the main text for the children of primary schools, who have been interviewed to see the understanding of the science concepts in the try out, pilot, and main studies. Such books contained a wider range of science concepts as compared to other books found in book stores, libraries or elsewhere in Pakistan. This study sample is the truly representative of the total books taught in all these three classes. All these books have been published after 2000.

Total, twenty textbooks were taught in classes I, III, and V, out of those twenty, eleven books were considered for the analysis on the basis of having any indication of science concepts.

Procedure. Textbooks taught at different classes in the federal primary schools of Islamabad. Textbooks were purchased from the National Book Foundation. NBF is the responsible organization for the development, printing, publication, and distributing textbooks freely to the federal schools. These books are given to the children free of cost.

The following diagrams show the commonality of the subjects taught at classes I, III, & V levels. Majority of the subjects are the same. However, these subjects vary in the course contents, volume, text, material, knowledge, vocabulary, and illustrations at all three levels (see Appendix D for complete proofs).

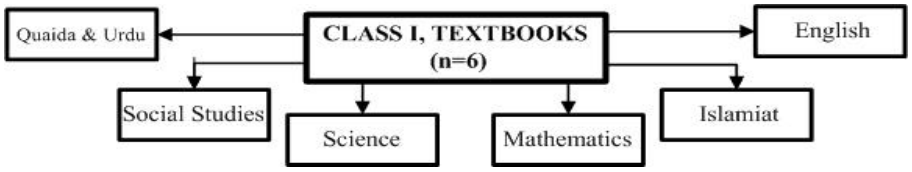


Figure 2. Subjects taught in class I

Six subjects (courses) taught in the class I. In all these six textbooks, evidences for science concepts were found. There are two different books for Urdu. One is called *Nia Qaida* (New Book); this is taught as a first book of language learning. Once the child finishes it, then he is taught the more difficult one, which is

called a book of Urdu. However, we consider it one subject having two separate books.

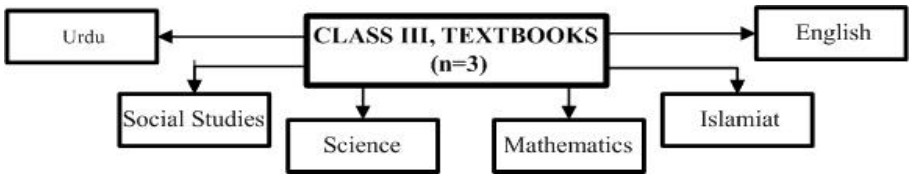


Figure 3. Subjects taught in class III

Islamiat, Social Studies, and Science, were among the three books in which no science concepts related to moon were found. So, only three books out of six were taken for analyses; Urdu, Mathematics, and English. There are two parts (I, & II) of Urdu, so two separate books are taught to the children. However, it was considered one subject having two separate books. The researcher asked to a senior class teacher to tell the reason why these two books are taught in this class. She was of the view that almost ten years back the subjects of Islamiat and Social Studies were not the part of the syllabi. Rather the contents of the Islamiat and Social Studies were included into these two books. This was the responsibility of the class teacher to teach 'separate' lessons related to these two broader areas. But later on the education ministry introduced these two subjects separately in the syllabus. But the two Urdu books remained the same (see Appendix E for complete proofs).

Her explanation was cross checked with looking into the Urdu books, and it was found, rightly so. Because these two books contained different subject and content areas related to topics having the background of Islamiat and Social Studies in them.

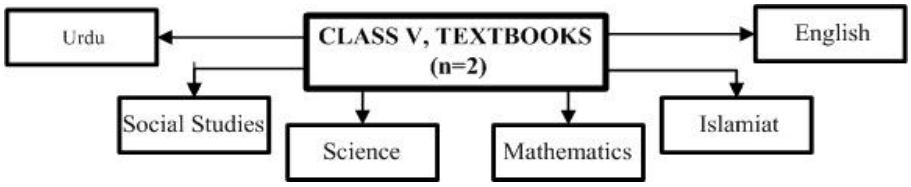


Figure 4. Subjects taught in class V

The total numbers of subjects in class V are the same as taught in class III. However, Urdu has not been divided into two parts. In class V, there are four subjects in which there was no evidence found related to moon concepts. These subjects were; Islamiat, Social Studies, Science, and Mathematics (see Appendix F for complete proofs).

Selection of the text material for content analyses. Two-steps analysis was done for the books. As a first step, books were sorted into those including explicit or implicit representations of the science concepts of natural phenomena of moon, and those not having such concepts. Three books in class III were found without having any concepts, whether implicit or explicit. These books were Social Studies, Islamiat, and Science. This situation is even bad regarding the books for class V. There were also four books; Urdu, Mathematics, Islamiat, and Social Studies (a very few diagrams but no natural phenomena), having no representation of science concepts related to natural phenomena, particularly, the moon.

As a second step, each remaining textbook was read, line-by-line, by the researcher to examine the presented science concepts therein. The researcher read completely through the main text to identify the concepts with which students could

be expected to come in contact with their academic life. Such material was marked with pencils and pointers. Then each identified material was entered into the database by the researcher for further analyses (see the result section for further detail).

Member check. After the main text identified by the researcher, this was presented to a team of three senior psychologists and researchers of the field to have a feedback, suggestions, and input on identified science concepts. After the consultation and discussions with the experts, final themes were identified. The researcher kept on consulting with those experts at each step and level of analyses to avoid the subjectivity.

This is important for research related to textbook analyses that how the science concepts have been presented in the textbooks, to keep the interest of the children in the subject matter. For this purpose, through a mixture of quality writing, excellent photography, engaging graphics and layouts, and topic selection, the books directly address children's interests. The ways in which science concepts have been presented in books; the ways in which the books delineate and or integrate content areas; and the extent to which they encourage scientific thinking, understanding, and appreciation is important to examine (Ford, 2006). These points were also taken into consideration in the analyses of the results (please see the result section).

Study 2

The Main Study

Main study was the replica of the *Interview Analyses* done in the pilot study (Phase II, Step IV).

Objectives of the study. After having done the Interview Analyses and obtained initial results, it was thought important to explore further and draw inferences on a larger sample. Keeping the same methodology, procedure, and analysis techniques, as adopted earlier in the study of Interview Analyses was employed to get the final results. Therefore, the main purpose of this study rested on identifying sources of children's concepts of the moon on a larger sample to get a more clear and detailed picture of the phenomena.

The literature of the previous researches on children's conceptions of the moon consists of surveys or multiple choice instruments (Baxter, 1989; Dai & Capie, 1990; Kuethe, 1963). These methodologies allowed participants to choose responses from those that were featured on the instrument. This is possible that the participants could have had alternative ideas which were not represented on the survey. Therefore, this main study featured to investigate, discover and interpret children's understanding of natural phenomena of the moon. In this way, children's existing concepts of the phenomenon of the moon could be identified and educators could use this information to create or modify instruction that better meets the needs of learners.

Method. The objectives of the main study required to keep the same methodology as adopted in the initial phase II, to seek out the answers of the questions of this study.

Sample. Sample of the main study consisted of 24 children. The issues of gender, classes, and ages were kept same as adopted in the pilot study (Phase II, Step IV).

Procedure. Final analysis rested on the interviews with the children. Each interview was recorded and then transcribed for further analysis. Same data analysis systems and techniques were applied, as used earlier in the pilot study. In the main study, similar coding schemes were used to assess the scientific views of the children's understanding of the phenomena of the moon.

After interviews were completed, systematic content analyses were completed to identify themes pertaining to understanding of the moon concepts among the children. A list of participant statements was generated. One list included responses describing common confusions, misunderstandings or misconceptions related to the phenomena of the moon. The statements from each interview were sorted according to their main message.

Member check. Each interview transcript was examined for detailed content analyses by a group of three experts for determining which themes were highlighted within each interview. Final categories, findings and themes were established after the independent analyses of the experts.

To view the complete results please see the next chapter.

Chapter-III

RESULTS

Study 1

Phase I: Try out

The interview consisted of questions related to emergence of the moon, whether it is alive, does it walk, stories about the moon, appearance of the moon, what are the sources from where the children get knowledge about the moon (artifacts, social institutions, including parents, teachers, and media etc).

The main results are summarized in the different themes emerged out of the responses of the children.

Theme 1: Moon and Allah (God). Khoala told that "moon" is the blessing" from Allah. And "moon gets light from Allah" and at another occasion she described that the moon emerges on "Eid". Another child named Muniba described that moon is "one", because Allah is One and Omnipresent, that is why moon is also one, and at another occasion she asserted that moon appears at night, at the time of 'Maghreb' (sunset). Waqar Shah also thought that moon appears on special occasions like, on Eid, and in the month of Ramadan (the month of fasting).

Theme 2: Stories of moon. The children can get the knowledge about the natural phenomena through folk tales and stories heard by parents and elders. For example, Muniba listened a story of fairies through her mother. And she believed that

'fairies' lived at the moon, and there was an old woman who lived at the moon, and moved the moon, she believed that moon was alive, but when she was asked that what the moon ate, then she thought that it is the old woman, who eats. Khoala's papa and mama also told her about the *eclipse* of moon. Waqar Shah was also taught and told about moon by the teachers and his elder brother.

Theme 3: Artifacts/psychological tools and moon. Psychological tools help in the shaping of conceptions of the moon. Children can learn about the moon and understand about the moon from Pakistani flag that has a moon on it. All these three children had seen moon on the Pakistani flag on their way home and within the school boundaries, pictures painted on the walls of the school, and printed in the books.

Theme 4. Movement of the moon. A common misconception found in the responses of the children was that moon could walk. To a question about 'moon walk', Muniba, Khoala, and Waqar Shah responded that it seemed to them that moon was walking and it walked along with them, whenever they saw it while walking. Moreover, these children were of the view that moon could walk along with two persons.

Theme 5: Moon as a living/non living object. Muniba and Khoala both believed that moon was alive. In response why Muniba believed that moon was alive, she said because, 'fairies' live at the moon, and there is an old woman who lives and moves the moon, and she also believed that moon eats, and the old woman eats, too.

On the contrary, Waqar Shah held a realistic and scientific view, he regarded that moon was not alive, there was sand on it, and no one can live on it. His teacher had told him this view.

Discussion

Main thrust of this study was attempting to accomplish these things; are there any conceptual changes being influenced by the dominant cultural patterns? Alternatively, is there any cultural relevance in the formation of the student's concepts about the natural phenomenon? An attempt was also tried to look at whether a specific culture plays any role in the acquisition of science concepts.

Children achieved their knowledge about moon through different sources. The important source is the relevant culture in which they lived. Strong cultural and social factors influenced the children's conception of the moon. Such concepts may have developed through their interactions with the world, including parents, teachers, and artifacts. Results showed that the respective cultural patterns including the religious rituals played a significant role in the understanding of the natural phenomena of moon. This influence can be positive and negative in terms of learning science concepts in schools, from books, and through parents or elders, etc. The ideas that children developed may or may not be consistent with the social or cultural environment.

The results of this try out study suggest that further investigation of the phenomenon can produce more interesting results. So, this initial try out proved to be a guiding force for further research and analyses. Further explorations were done on

this issue for greater implications from the psychological, educational, cultural and social perspectives. The results of this try out guided the researcher for a pilot study to get more meaningful indicators related with specific cultural artifacts that play an important part into this whole process of thinking, on a comparatively larger sample. Therefore, it was decided to move one step ahead, to investigate further, this research had to enter into second phase for more in-depth and detailed explorations of the phenomena under study.

Phase 2

Step 1: The Pilot Study. The results of pilot study are shown below.

Table 1

Demographic Information Related to Types of Schools and Classes of the Children

	Class I		Class III		Class V		
Schools	Boys	Girls	Boys	Girls	Boys	Girls	Total
1. ICG	_	1	_	_	_	_	1
2. ICB	_	_	_	_	1	_	1
3. IMCG	_	_	1	_	_	1	2
4. IMCB	1	_	_	_	_	_	1
5. FG (Rural)	_	1	_	1	_	_	2
6. FG (Urban)	_	_	_	1	1	1	3
Total	1	2	1	2	2	2	
G. Total	3		3		4		10

Table 1 shows basic demographic information about the sample of schools and children for this pilot study. There were total 10 children who participated in this

study. There were six girls and four boys. The schools represented all types of schools administered at federal level.

Table 2

Categories of Questions, Sources of Information, and Related Frequencies from Children's Responses

Categories of questions related to the understanding of the phenomena of the moon	Categories of possible sources of information	Frequencies of responses within category of questions related to the understanding of the phenomena of the moon	
1. Direction (position) related concepts	(a) Personal perception & observation of the phenomena	(a) *f*=10 (d) *f*=1	
2. Appearance (visibility) of the moon	(b) Religious teachings & Allah (God)	(b) *f*=3 (a) *f*=1	(f) *f*=1
3. Movement/walk related understandings	(c) Class Teacher	(c) *f*=1 (a) *f*=9	(b) *f*=2 (d) *f*=3
4. Moon as a living object	(d) Parents	(b) *f*=2 (d) *f*=2	(a) *f*=5
5. How many moons	(e) T.V	(d) *f*=1 (c) *f*=1	(a) *f*=4
6. Origin of the moon	(f) Curriculum related books	(c) *f*=1 (f) *f*=2	
7. Beginning of the moon	(g) Parents & Teachers		
8. Emergence of the moon	(h) Artifacts, Magazines, Newspapers & Story Books	(h) *f*=1 (a) *f*=2	(d) *f*=2 (i) *f*=1
9. Disappearance of the moon	(i) Siblings	(i) *f*=1	(a) *f*=3
10. Story related to moon	(k) Peers	(e) *f*=1 (c) *f*=1	(f) *f*=1 (d) *f*=1

Note. (a)=34, (b)=7, (c)=4, (d)=10, (e)=1, (f)=4, (g)=0, (h)=1, (i)=2, (k)=0

Table 2 shows categories of possible sources of information on one hand against the categories of questions related to the understanding of the moon on the other hand. In third column, it shows the frequencies of children's responses

regarding their understanding of the moon concepts with respect to their Personal Perception and Observations. The most common responses were related to Personal Perception and Observation of the phenomena, whereas, the least responses were related to Parents and Teachers, Class Teacher, T.V., and Curriculum related books.

Table 3

Frequencies of Important Scientific and Non-scientific Conceptions of the Moon, According to the Responses Class Wise from the Children

Categories of questions	Class I		Class III		Class V	
	S	*NS*	*S*	*NS*	*S*	*NS*
1. Direction (position) related concepts	1	1	2	1	4	
2. Appearance (visibility) of the moon	1	1	1		1	2
3. Movement/walk related understandings	3	1	2	4	1	9
4. Moon as a living object		2	1	3	2	2
5. How many moons	2	1	2	2	4	
6. Origin of the moon				1	1	1
7. Beginning of the moon				1	1	1
8. Emergence of the moon		2		1	1	3
9. Disappearance of the moon		2		2		3
10. Story related to moon				0		1
Total	7	10	8	15	15	22

Note. S = Scientific, NS = Non-Scientific

Table 3 indicates high frequency of misunderstanding of scientific phenomena of moon in class V, and a low frequency in class I. The table also shows the trend of high level of misunderstanding as classes go higher.

Table 4

Frequencies of Important Scientific and Non-scientific Conceptions of the Moon, According to the Responses Gender Wise from the Children of Classes I, III, & V

Categories of questions	Boys		Girls	
	Scientific	Non-Scientific	Scientific	Non-Scientific
1. Direction (position) related concepts	4		5	1
2. Appearance (visibility) of the moon		1		2
3. Movement/walk related understandings	2	5	4	10
4. Moon as a living object	2	2	1	5
5. How many moons	3	1	3	4
6. Origin of the moon	1	1		1
7. Beginning of the moon	1	1		1
8. Emergence of the moon	1	2		4
9. Disappearance of the moon		2		4
10. Story related to moon		1		
Total	14	16	13	32

Table 4 shows that the overall level of misunderstanding of scientific phenomena of moon in all three classes is higher among the girls. The results also show among the categories of questions, the most prevalent misunderstanding is related to the ‘movement/walk’ of the moon.

Table 5

Frequencies of Important Scientific and Non-scientific Conceptions of the Moon, According to the Responses Gender Wise from the Children of Class I

Categories of questions	Boys		Girls	
	Scientific	Non-Scientific	Scientific	Non-Scientific
1. Direction (position) related concepts	1		1	1
2. Appearance (visibility) of the moon				1
3. Movement/walk related understandings	1		2	3
4. Moon as a living object		1		2
5. How many moons			1	1
6. Origin of the moon				
7. Beginning of the moon				
8. Emergence of the moon		1		2
9. Disappearance of the moon				2
10. Story related to moon				
Total	2	2	4	12

Table 5 shows the high frequency of misconceptions of scientific phenomena of moon among girls of class I. The results indicate the most areas of misunderstandings are related to movement/walk, how many, and emergence of the moon.

Table 6

Frequencies of Important Scientific and Non-scientific Conceptions of the Moon, According to the Responses Gender Wise from the Children of Class III

Categories of questions	Boys		Girls	
	Scientific	Non-Scientific	Scientific	Non-Scientific
1. Direction (position) related concepts	1		2	
2. Appearance (visibility) of the moon				
3. Movement/walk related understandings		2	2	3
4. Moon as a living object	1			3
5. How many moons	1		1	2
6. Origin of the moon		1		
7. Beginning of the moon		1		
8. Emergence of the moon				1
9. Disappearance of the moon				1
10. Story related to moon				
Total	3	4	5	10

Table 6 shows the high frequency of misconceptions of scientific phenomena of moon among girls of class III. The most misunderstood areas of concepts are related to movement/walk, moon as a living entity, and more than one moon.

Table 7

Frequencies of Important Scientific and Non-scientific Conceptions of the Moon, According to the Responses Gender Wise from the Children of Class V

Categories of questions	Boys		Girls	
	Scientific	Non-Scientific	Scientific	Non-Scientific
1. Direction (position) related concepts	2		2	
2. Appearance (visibility) of the moon		1		1
3. Movement/walk related understandings	1	2		6
4. Moon as a living object	1	1	1	1
5. How many moons	2		2	
6. Origin of the moon	1			1
7. Beginning of the moon	1			1
8. Emergence of the moon	1	1		2
9. Disappearance of the moon		2		1
10. Story related to moon		1		
Total	9	8	5	13

Table 7 shows the high frequency of misconceptions of scientific phenomenon of moon among girls of class V. The results of this table also show the most prevalent misunderstood area is related to movement/walk of the moon.

Table 8

Frequencies of Responses and Sample Statements of Specific (Mis) Conceptions about Moon, Explained By the Children in Interviews

Types of questions pertaining conceptual understandings	Sample statement of interviewee's misconception (s)	Frequencies	Sample statement of interviewee's conception (s)	Frequencies
Have you ever been for a walk or drive outside at night? [If yes]			*….yes…there are stars and ……..moon in the sky..* (Sana, III)	10
Where was the moon? Or Was moon in the sky?	*….this way…every where..I don't know…No..*(Hamna, I)	2	*...up there in the sky…towards 'Maghreb'…in the West!!!*	9
Can you tell me anything about it? [if no]	*No..Know nothing..* *..*(Hamna, I)	7	*…its white…Light* *Illuminated* (Adnan, V)	3 1
Did you notice anything about it? [if no]	*….No…..…*	7		
Did it look like moving…?	*….yes…it walks….and move…..*(Muniba, V)	9	*.No….*	1
How does that happen?	*……don't know…..…*	9		
Can it follow you? [if yes]	*..yes…it does so*	8	*…but moon does not walk….its our earth…that moves..My.Mama…told me…..*	2
Why does it do that? [Or if no] Why not?	*...don't know….* *..will of Allah..*(Shazia, V)	9 1	*…*(Ali, V)	3
Has anyone else talked to you about these things? [if yes] What did they say about it?	*…….. No* *.yes..teacher..sand on the moon.one cant live there.. man can't live.* (Ali, V)	9 1		
If child says that moon can follow you] Can it follow two people at a time? [if yes] Tell me more about that. [If no] why not?	*Yes…it can walk with two persons…I have seen it…walking with two* *….yes…it looks that it is walking with me….. Allah does so.*(Shazia, V)	6 5 3	*No..it will not walk with two persons.*(Shazia, V)	2
What if you went this way [pointing one direction] and I went that way [pointing the opposite direction]. Which one of us would it follow? Why?	*…both of us...*	5		

Continued…

Types of questions pertaining conceptual understandings	Sample statement of interviewee's misconception (s)	Frequencies	Sample statement of interviewee's conception (s)	Frequencies
Is the moon alive? How do you know that?	*.I don't know….* *..yes..because ..it walks…with* *..myself…*	5 3 1	*..no its not alive…* *it.. takes light from the sun..*(Muniba, V)	2
Is there more than one moon? [if yes]	*…yes…*	5		
How many moons are there? How do you know?	*..so many…*	3	*one..* (Emaan, III) *..Teacher and brother …told me…*(Ali, V)	8 1
How did the moon begin? Do you have any idea?	*.. I don't know..* *..from the sky* (Ali, V) *…no…*	3		
Where does the moon go when you can't see it?	*By itself…from its house..* *And goes to its house..from West* (Emaan, III) *….clouds cover it…*	5 6	*It comes in the night. because it is sunlight…*(Ali, V)	2
Total		112		44

Table 8 shows comprehensive qualitative results of the interviews conducted with the children. Misconceptions or alternative conceptions related frequencies are in greater numbers as compared to the conceptions of the natural phenomena of the moon. The frequencies of misconceptions (112) outnumbered the frequencies associated with conceptions (44) of the moon related concepts. The results show majority of the misunderstood concepts are associated with movement of the moon, moon as a living object, and disappearance of the moon. At the other hand, majority of the children had high frequencies of responses related to moon visibility.

Table 9

Frequencies of Children, Who Responded Specific (Mis) Conceptions of the Moon (Narrative Mode in form of Stories)

Types of questions pertaining conceptual understandings	Sample statement of interviewee's misconception (s)	Frequencies of the statements	Sample statement of interviewee's conception (s)	Frequencies of the statements
Can you tell me a story about the moon? Or do you know any stories about the moon?	*I … don't know about any story*	7		
Could you make up a story about the moon?	*Once upon a time…there was a grandma of the moon…grand ma lived on the moon.*	1	*…this moon takes light from the sun…and moon is very thin…*(Muniba, V)	1
That story you just told me …did it really happen?	*.I have read in the books…..And watched on T.V* (Ali, V)	1		
What really happens?	*..These things are real…*	1		
How do you know?	*From the science book*	3	*..my father told me..* (Muniba, V)	1
All questions that I asked you today, and you answered, tell me what really happens? [if yes] How do you know it really does happen? Where did you learn this? [if no] what really does happen?	*Father…mother.. told me…*	3		
Total		16		2

Note. In ( ) names, classes, & school types of the children.

Table 9 shows the frequencies related to the responses regarding the story related questions by the children. Most of the children could not make a story about the moon or do not know any story related to the moon. There were only two children who were able to narrate a story.

Table 10

Child's Story Telling Using the Vygotsky's Scheme of Concept Development (N=2)

Basic conceptual structures (modes of organization) in the stories	Class I	Class III	Class V	Total
1. Heaps (perception)			1	1
2. Sequences (complexes)			1	1
3. Primitive Narrative (concrete)				
4. Unfocused Chain				
5. Focused Chain (Pseudo concepts)				
6. Narratives				
Total			2	2

Table 10 shows that the basic conceptual structures of the stories told by the children of class V corresponds on the basic and initial levels of conceptual structures, however, it is expected to be on the higher levels according to the class and age levels.

Discussion

The results can be interpreted into two main streams. First of all the results show that children have misconceptions of the natural phenomena of moon on the whole (112), and these misconceptions are more prevalent among the girls. This may be due to the greater sample size of girls (6) as compared to the boys (4). Secondly, this trend is gradually increasing as the children go into higher classes. One possible reason could be that in this pilot study majority of the children belonged to higher classes, i.e., class V (4), class III (3), and only (3) in class I. That means the majority of the frequencies were counted for higher classes. That eventually outnumbered the responses for the higher classes as compared to the class I. Apart from the issue of

sample size, there are scientific evidences, that boys take more interest in science and they diverge early towards science within a context that promotes its exploration (Adamson, Foster, Roark, & Reed, 1998).

The results indicated that the children are developing understanding of the concepts with their personal perception, the cultural factors like artifacts, parents, siblings, teachers, curriculum, and media are playing its minimal role in the understanding of the science concepts. Whereas, all such psychological tools, according to Vygotskian sociocultural aspect of human cognition, are supposed to have a profound effect in the development of concepts including science concepts (Kozulin, 1998).

The most common misconceptions among the children found were the inability to understand the phenomena of moon as it was not moving or walking object. This indicated the poor understanding of the whole phenomena. That indicated not only curriculum, but teachers, parents, and other sources of information are not transforming and transmitting the true knowledge. However, it was noted that girls hold more unscientific views of movement and walk related concepts as compared to the boys (Table 7).

The explanations given by the children about the movement of the moon can be regarded into five different stages. The first stage could be magical: moon is moved by walking. The moon obeys us at a distance. The average age is (5) of the children and class is I. The second stage could be animistic and artificialist: moon moves or walks because God make it move. The average age is (6) for this stage, and class is III. In third stage, the average age is (7), and class V, clouds are supposed to move by themselves, though the child says nothing definite as to how this movement

is affected. In addition to this, the movement is conditioned by moral and physical causes, which shows that the artificialism has simply been transferred to the objects. It may be the sun or earth etc. that make the moon move and walk along; only the heavenly bodies determine these movements, not as a physical cause determines its effect. During this stage, the child is unsure about the "how" of the moon's movement, but it is clear that the child has in back of his mind a motor schema which prepares the way for the explanation which comes during the fourth stage. In the fourth stage, the children, *consider that wind pushes the moon.* The average age of this stage is 8. The fifth stage is reached (average age 9); a correct explanation is found (Piaget & Valsiner, 2001).

The other commonly misunderstood concepts found were related to moon as a living object. Most of the children considered that moon was alive, because, it could walk and move along with them. That means majority of the interview responses were consistent with Piaget's stage of physical causality. However, most of the responses came from the girls as compared to the boys (Table 4). The results showed that most of the explanations of the children's ideas about the moon as a living object are the reflection of childish animism and artificialism.

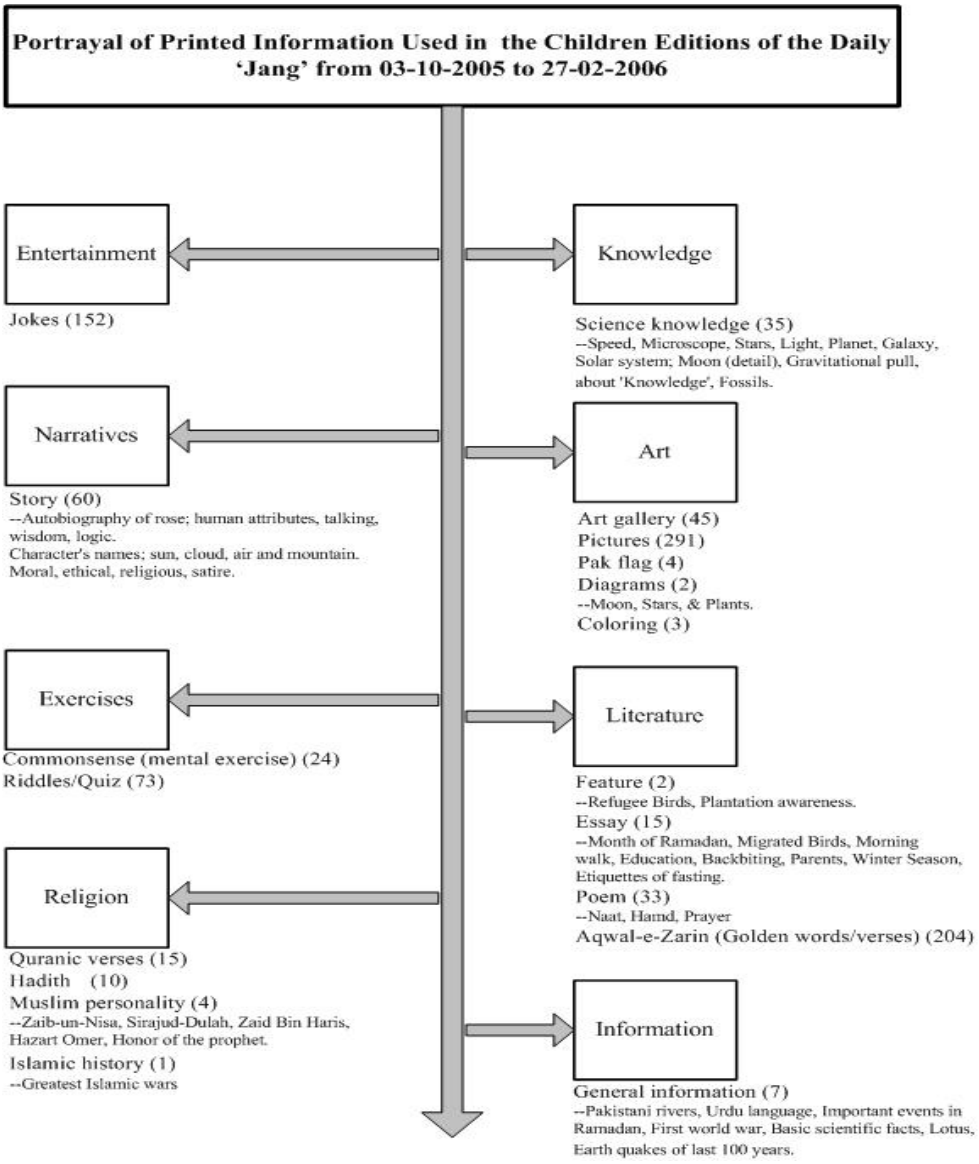
The other areas in which most of the misunderstood responses found are related to emergence and disappearance of the moon. Such responses are related to the pre-causal stage, according to the Piagetian stages of development, in which things happen by "magic" (Piaget, 2007).

Narrating a phenomenon is an important aspect of science learning and teaching. In this study, it was tried to examine how children come to know understand the natural world through preoperational tendencies of thought, combining with how

these stories are embedded through their culture? Astonishingly only two children out of ten were able to narrate a story about the moon that showed a poor comprehension of the phenomenon. The two stories told by Ali and Muniba, according to Applebee's scheme of the structures of children's stories can be classified as "Heaps", and "Sequences" (Applebee, 1978). That means these stories cannot be categorized as an organized structures. According to him these two schemes of the structures of children's stories are less sophisticated or coherent stories (Table 10). None of the story can be placed as real. The basic conceptual structures of the stories told by the two children correspond on the basic and initial levels of conceptual structures; however, it was expected to be on the higher levels in accordance with the class and age levels, according to the Vygotskian perspective (Table 10).

Phase 3

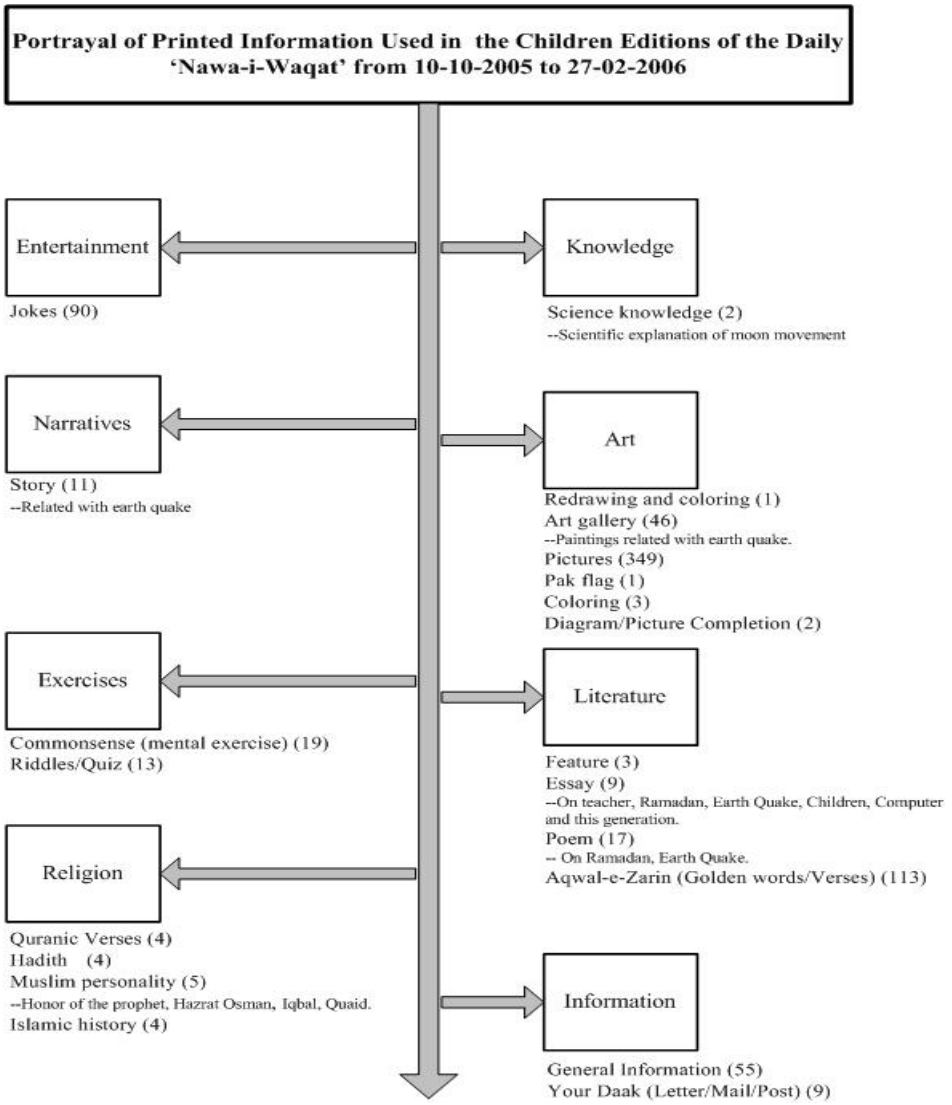
Step I: Newspapers Analyses. In this section, the analyzed data is presented in the forms of figures.



Number in ( ) represents instances of occurrence within 'Small Frames' of the study.

Figure 5. Types of information or material established as a means for displaying knowledge in the daily 'Jang'.

Figure 5, shows that majority of the space covered in the daily Jang is by the pictures of the children. The other prominent material is golden words. The knowledge or information about the science concepts is very limited. Mostly, the knowledge is of very basic or factual level.



Number in ( ) represents instances of occurrence within 'Small Frames' of the study.

Figure 6. Types of information or material established as a means for displaying knowledge in the daily 'Nawa-i-Waqat'.

Figure 6, shows majority of the space covered is by the pictures of the children. The following space is covered by the golden words. Very little space is attributed to the science concepts.

Discussion

The overall results of the both national dailies; 'Jang' and 'Nawa-i-Waqat' indicated minimal portrayal of science knowledge. The kind and contents of the science knowledge was of factual level. This was indicative of having least contribution in the development and acquisition of science knowledge. Moon concepts are rarely found in the entire editions of both the newspapers. Therefore, it is hard to assume the tangible role of newspapers contextual material in understanding of the moon concepts in the children.

After viewing these results, it seemed justified to rule out further probing of the newspapers textual as well as printed material and its presumed role in the development of the science concepts.

However, it seemed important to focus the direction of the research towards the analysis of the textbooks to find out any textual or printed material related with science concepts, which could have contributed in understanding the science concepts of the children.

Step2: Textbooks analyses. The following sections will show the results related to textbooks analyses.

Style and presentation of pictures/illustrations related to natural phenomenon, particularly, the moon, is presented in this section. To explain certain concepts, almost all the writers of the textbooks use the pictures and illustrations. So pictures and illustrations are considered to be an important component of any school or textbooks. Therefore, this is necessary to examine to what extent and how such types of pictures and illustrations have been used in the textbooks of primary schools in Pakistan.

Total forty-five diagrams, pictures, and illustrations were found in all the textbooks of classes I, III, & V (see Annexure D, E, and F for complete proofs). Out of these forty-five items, thirty-five pictures, diagrams, and illustrations are directly related to the moon. Thirteen pictures are related only with the Pakistani flag. One star and one moon (crescent) is the part of the flag. So, it is considered these types of pictures do not help in better understanding of scientific phenomena. However, children may know the picture of the moon only. There are eighteen other pictures and diagrams that merely show the moons or crescents.

In all the twenty books, only once (see Annexure E), four shapes of moon have been mentioned (Ajmal, 2003, p. 62). At another occasion (see Annexure F)., one original picture of full moon and another is the first man on the moon have been shown (Shami, 2006, p. 96).

Apart from the natural phenomenon of the moon, there are few other pictures and illustrations that can be related to the natural phenomena. Most of them are related to sun. There are seventeen pictures of the sun.

There are seven other pictures, showing other natural phenomena like rainbow, clouds and raining, a cascade and process of evaporation, stars in the sky etc.

Topics, titles or heading indicating a relation to natural phenomenon of the moon. This was considered important to see the explicit and implicit representation of science knowledge in relation to natural phenomena of the moon in the textbooks. The analysis was done from each and every aspect to find any sources presented in any form in relation to science concepts, whether in the form of sentences, words, phrases or paragraphs.

There were five topics, which contains the word moon (see Annexure D, E, and F). The titles or topics are like this; Sun, Moon, Stars (Muhammad, 2008, p. 49); The Sun, The Moon, and The Stars (Hussain, 2003, p. 53); Moon of Earth (Jalalpuri, Raja, Nawaz, Riaz, Rehman, & Muhammad, 2005, p. 15); Lunar and Solar Calendar (Rashid, 2005, p. 152); The Eid Moon (Ajmal, 2005b, p. 80).

There are few other topics in the textbooks of classes I, III, and IV, which are related to natural phenomena apart from the moon. Though they do not contain directly any title related to the moon, however, such topics may contain some how the text or material related to the natural phenomena. The details are presented in the next paragraphs, topics covered separately from all the textbooks of respective classes (see Annexure D, E, and F for complete proofs).

Class I. The topics are like this; Fairy's Stair (Muhammad, 2008, p. 44); Pre-Numeric Concepts, Concept of Numeric, Geometry (Rashid, 2003, pp. 16, 17, 96); *Dua* (Prayer) (Muhammad, 2008, p. 33); Islamic Beliefs, Allah and his Oneness (Mustafa, 2004, p. 1); Directions (Hameed, 2005, p. 9); Living and Non-Living things, Energy, Earth and Space (Hussain, 2003, pp. 26, 48, 53-55); Look and say, Work book, Writing Skills (Ajmal, 2005a, pp. 9-11, 16, 19, 21).

Class III. National flag, Moon of Earth, Allure (poem), Humans, Communication, Water, Science Exhibition (Jalalpuri, Raja, Nawaz, Riaz, Rehman, & Muhammad, 2005, pp. 6, 15; Jalalpuri, Raja, Nawaz, Riaz, Rehman, & Muhammad, 2003, pp. 12, 20, 30, 53, 75); Function of Leaf, Gases, Earth and Spaces (Hussani & Shaheen, 2004, pp. 15, 38, 65); Greetings and Courtesies, My School, Using Vocabulary, Vowel Sounds (Ajmal, 2003, pp. 1, 10, 26, 62, 68, 72); Algebra Operations, Lunar and Solar Calendar (Rashid, 2005, pp. 60, 152).

Class V. Our neighbors in the Solar System, Natural and Artificial Satellites (Shami, 2006, pp. 96-97); Means of Communications and Transportation, Services (Ajmal, 2005c, pp. 89, 107); The Pakistan Flag, Islamic Festivals, Seasons (Ajmal, 2005b, pp. 54, 80, 97).

Classification of textual material related to science concepts (natural phenomenon of the moon in particular) presented in the textbooks on heuristic characteristics and critical comments on the text. The main body of information or material related to science concepts is presented in a lesson or chapter, therefore, a

lesson or chapter of the book is considered as the unit of analysis. To capture a holistic picture based on scientific bases, the written material has been classified into six different categories. Each category is attributed to some characteristics, containing a set of certain information in it, which are presented in the main body of the text. It could be a sentence, a paragraph or a whole lesson etc. these six categories are as follows; Methods, Individuals, Science Knowledge, Aims, Natural Phenomena, and Context. Detail of each such category is presented in the table 11.

Table 11

Classification of Textual Material and Critical Comments on the Presented Science Concepts in the Textbooks

Heuristic characteristics of the textual content	Description of sentences & paragraphs in the main body of text content	Critical comments on the content
Individuals: Scientists, naturalists, and others including children engaged in science particularly, natural phenomena.Information containing sociological and cultural perspectives.	Narrative; one boy & a girl talking about rainbow. The girl says that it is a stair of sky. Boy says that it is the stair of fairies. Through which *Parees* (Fairies) go to the sky. Father corrects by telling the scientific phenomena that when sunrays cross the droplets then we see the seven colors of sunrays. But sometimes children call it the stair to sky [Jalalpuri, Raja, Parveen, & Muhammad, 2003, pp. 44, 45; (see Annexure D)].	This lesson is a good depiction of natural phenomena of rainbow. This shows that there are some alternate conceptions about the natural phenomena among the children. And those alternate or misconceptions have been corrected in a best way by the father. That is an important source of passing knowledge to the young children.
	Stars are twinkling in the sky, these resemble with lamps. They are far from us, that is why they look small. Then the moon emerges. The light of stars is getting dim. Look how bright this is? Due to this brightness every thing is visible. Some times it is small and sometimes large. Moon of first night is not easily visible. Than it becomes	Natural phenomena of light, brightness, shapes of moon, stars, hotness, and sun has been described. .

Continued…

Heuristic characteristics of the textual content	Description of sentences & paragraphs in the main body of text content	Critical comments on the content
	so large, it looks like a round plate. Moon looks pleasant every day, but the people feel happy seeing the Eid moon. The sun is a source of brightness & hotness. The sun brightens the stars and moon. Sun and moon are blessings of Allah [Jalalpuri, Raja, Parveen, & Muhammad, 2003, pp. 49-52; (see Annexure D)].	
Methods: The activities, methods, and tools engaged in or utilized by children investigating science specifically, natural phenomena.	Cardinal points. Four directions are related with the rotation of sun. In worksheet there is a question, where is Kaba in Pakistan? [Hameed, 2005, p. l9; (see Annexure D)].	Simple concepts of four directions have been introduced with the identification of Kaba.
	Match the correct picture [Ajmal, 2003, p. 72; (see Annexure E)].	Very basic information about the shape of the moon.
Science Knowledge: Factual information as certain knowledge, developing knowledge, definitions and terminology of science.	Sun, Moon, Torch & Electricity are the sources of Light [Hussain, 2003, p. 26; (see Annexure D)].	The Sun and the Moon have been described as source of Light.
Philosophic perspectives.	We get Heat and Light from Sun, Fire, Electric & Oil Lamp, and Candle. But we do not get it from the Moon [Hussain, 2003, p. 52; (see Annexure D)].	The difference between the Sun and the Moon is that sun is heat as well as light source. Whereas, we do not get heat from moon.
	During daytime we see the sun in the sky. During night we see the moon and stars in the sky [Hussain, 2003, p. 53; (see Annexure D)].	Very basic concept of the Sun, the Moon and stars have been illustrated.
	Two-way communication between father & daughter. Girl has to prepare a Pakistani flag, for class competition. The girl inquires the rational of star & moon on Pakistani flag. The father explains that these are symbol of illumination, eminence and nobleness [Jalalpuri, Raja, Nawaz, Riaz, Rehman, & Muhammad, 2005, p. 6; (see Annexure E)].	The inquisitive questions of the girl are nicely answered by the father in a dialogical format.

Continued…

Heuristic characteristics of the textual content	Description of sentences & paragraphs in the main body of text content	Critical comments on the content
	Stars are talking with each other. Come closer to the travelers and guide them. They are helpful for humans. When the sun comes out, the light of stars become dim. Sun is responsible for this dimness. One star asks to other, never mind now the sun will give light to these travelers. Star 1(S-1), does moon give light? Star 2 (S-2), this is a secret; the moon does not have its own light---it glitters from the light of the sun. S-1, moon is not the part of the sun! S-2, this is the part of the earth. That separated from it, sun was also the part of the earth long ago. S-1, I have heard that there are mountains, oceans and air on the earth---are these things on moon also? S-2, to some extent. S-1, what do you mean? S-2, moon has tall mountains, sands, but no water and greenery. S-1, do people live, as they are on the earth? S-2, not yet----but they are trying to establish a village--then we will also go there. S-1, no we will not go there. It's not good to get closer to the people; they will come to us too. If they did so, sun heat will kill them. S-2, the sun heat helps the people a lot. S-1, how? S-2, look at wheat fields. If the sun will not have given heat, then wheat will not have ripped. No fruits would have ripped in the gardens. S-1, it only ripens crops. S-2, no, it gives light also. Light is essential for humans [Jalalpuri, Raja, Nawaz, Riaz, Rehman, & Muhammad, 2005,, p. 15-19; (see Annexure E)].	This is an excellent Lesson depicting the Concept for Light and Scientific Phenomena of moon in a narrative but dialogical format. The stars are showing human like attributes**.**
Aims: Purpose of scientific research, impact on humans, implications and applications.	Students are asked to fill in the blanks under each drawn shape of moon [Ajmal, 2003, p. 62; (see Annexure E)].	Students can be familiar with the shapes of the moon.

Continued…

Heuristic characteristics of the textual content	Description of sentences & paragraphs in the main body of text content	Critical comments on the content
	Artificial satellites like moon travel around the earth. They can take pictures, send radio & television signals. Can monitor movements of targets. Internet service work through these satellites [Shami, 2006, p. 97; (see Annexure F)].	Analogy of satellites has been related to moon.
	Spinning and rotation of the earth with the diagram and movement of earth, and sun in the center [Shami, 2006, p. 95-96; (see Annexure F)].	Solar system has been explained very well.
Natural Phenomena: Content areas and disciplines covered in the text explaining the scientific phenomena.	Brief explanation of scientific phenomena of satellites; those bodies, which revolve around another heavenly body. Natural satellites are called moons. Planet earth has one moon. Moon has no lights. It reflects sunlight. Moon causes tides in the seas [Shami, 2006, p. 97; (see Annexure F)].	Advanced knowledge about the rotation of the moon has been explained.
Context: Historical, social, and religious contextualization of the scientific phenomena explained by the individuals through dialogue or poetry.	Conversation between mother, father, grandmother & a child. The child has seen the Eid moon. He shows the moon to on their family members. The religious background of Eid is described to the child by the elders [Ajmal, 2005b, p. 80; (see Annexure F)].	Social, cultural and religious back ground and aspect of the moon is told to the young generation.
	A farmer's routine life is shown. How he works from sunrise to sunset. Sometimes moon disappears. He enjoys the light of moon [Ajmal, 2005b, p. 97; (see Annexure F)].	The normal life of a villager is shown according to the natural routine of day and night.
	Hamd (Poetry) Praise of Allah. Master of Day night, sun, moon, and stars [Jalalpuri, Raja, Parveen, & Muhammad, 2003, p. 33; (see Annexure D)].	A girl and a boy sighting moon and praying, one girl sitting and praying

Table 11 shows detailed description of the textual material regarding how the science concepts related phenomena of the moon is presented in the textbooks. A reasonable

pool of material exists in the textbooks of class 1. A decreasing trend is observed in the higher classes.

Space of science concepts covered in the examined textbooks. Textbooks carry a wide range of different types of concepts including science concepts. The area and space allocated for each type of concept determines that how much particular set of concepts has been regarded by the authors and writers of the textbooks. The textbooks have also been examined regarding to what extend the concepts have been displayed on how many number of pages.

Table 12

Number of Pages Dedicated to the Science (Concept) Topics in Textbooks for Primary Classes

Textbooks	Class I	Class III	Class V	Total
Urdu	14	20		31
Islamiat	6		1	7
Social Studies	5		2	7
Science	11		3	14
Mathematics	6	2		18
English	6	6	5	17
Total	48	28	11	

Table 12 shows that the concepts related to natural phenomena are presented in the class one and least present in class five. The results also show a gradual decrease of concepts as the classes go higher.

Categories of images related to science concepts found in the textbooks. The images related to science concepts specifically natural phenomena, were found in the class textbooks and have been classified in 4 categories. Figurative images or figures (photos and drawings) include science concepts as well as natural phenomena (FI), second figure is related to communicative conceptualizations (CC), third figure is related to socially & culturally embedded images (SE), and fourth figure reports empirical data (ED).

Table 13

Categories of Images Dedicated to the Science Concepts in the Sample of Examined Textbooks for Primary Schools

Textbooks	Class I				Class III				Class V			
	FI	*CC*	*SE*	*ED*	*FI*	*CC*	*SE*	*ED*	*FI*	*CC*	*SE*	*ED*
Urdu	14		2		10	1	2	1				
Islamiat	1				1				1			
Social Studies	5	2			1				2			
Science	7	4	1	8	2				3	1		1
Mathematics	5				2							
English	6				6				4	4	1	
Total	38	6	3	8	22	1	2	1	10	5	1	1
Grand Total			55				26				17	

Note. FI = Figurative images or figures, CC = Communicating conceptualizations, SE = Socially and culturally embedded images, ED = Empirical data

Table 13 shows that the dedicated images of science concepts specifically concepts related to natural phenomena are higher in textbooks of class 1, and this trend is gradually decreasing in higher classes. Among the four categorized images, the number of *figurative images* is higher than the other three images.

Levels of content (themes within topics) relating to science concepts in textbooks. Special attention is required to analyze the 'contents' of the science

concepts presented in the textbooks to assess against certain criteria of levels. Thematic analysis of the published and written material in the textbooks has been carried out to see the qualitative properties of the presented science concepts. These contents have been formulated at seven different levels, ranging from 0 to 6, not possessing science concepts to high level of science concepts. For detail please see the Annexure 'A'.

Table 14

Frequencies Showing Criteria Levels (Themes within Topics) Related to Natural Phenomena Found in All the Examined Textbooks of Primary Schools

Levels of Content	Textbooks		
	Class I	Class III	Class V
LC 0	7	8	18
LC 1	46	21	12
LC 2	9	7	2
LC 3	2	4	1
LC 4	3	2	1
LC 5		1	
LC 6	5	1	

Table 14 shows that contents of science concepts are most frequent in class 1, whereas the overall trend is decreasing towards the higher classes. LC 1 means, some indication in title or diagram that this page can be related to science concepts at some level. That indicates the text books of class I contained the maximum science related understandings as compared to class III and V. Whereas, the textbooks showed least representation of higher levels of conceptual understandings like; LC 5, a

combination of the levels 2 and 3 (description and explanation of naturalistic phenomena in imaginative context)., LC 4, material that contains a pure scientific explanation., LC 6, combination of the levels 2, 3, and 4 (description, imaginative, and scientific explanation of science concepts)., and LC 3, naturalistic phenomena with some scientific explanation in imaginative context respectively.

Discussion

Analysis of the primary school textbooks revealed both predictable and unexpected findings regarding the topic under study. Some of the results in the conducted study lend themselves to an easier interpretation than others, especially the unexpected findings. The unexpected results which are more easily interpretable are discussed first. Then some possible explanations for the positive results are suggested.

One of the unexpected results was that the textbooks failed to provide information necessary for making sound knowledge of the concept of moon. However, majority of the text material provided only scanty detail on this topic, which seemed to be insufficient for concrete scientific knowledge, whereas depth and breadth of the coverage of the represented science knowledge exhibited low and limited scope for learning and acquisition of moon concepts. Topics related to moon concepts were supposedly thought to be essential within ‘science textbooks’ were difficult to find.

There were total forty-five diagrams, pictures, and illustrations representing the science concepts in all three textbooks. Out of which, thirty fives are directly

related to moon. Somewhat surprisingly, there were few differences in presenting different styles of concepts. For example, Pakistani flag is presented in each level of textbooks. All these diagrams, pictures, and illustrations merely show the moon without having analogy of moon related concepts, except there is only one example showing the moon phases in class III.

Another important aspect which was missing in the textbooks was the absence of the use of analogies. None of the textbooks contained description how to use analogies for a pedagogical improvements and aids used with the features to promote meaningful learning of science concepts in teaching methodologies.

Science should be represented in such a manner in the books that it should help in better understanding of science concepts. This has also been emphasized by Ford (2006) that the books should be designed in more appealing manner along with colorful photographs and illustrations. Throughout the sample books, important factual information related to science concepts had been presented in the forms of definitions, descriptions, and explanations of the contents considered appropriate for the children, whereas there is little within the books that could guide children to deeper understanding of the science concepts.

There are some passages describing scientific knowledge in the form of narratives---the statements in which stories are used to convey the science concepts in the best way. In such a passage, the father, not the teacher or scientist, was shown as a guide who corrected children's misconception of rainbow.

In the same book of class I, scientists, naturalists, and children were mentioned engaged in sociological activity embedded with cultural (dominant with Islamic religious) perspectives.

As it has been mentioned earlier that in most of the textbooks, scientific knowledge has been presented in factual form, representation of science as facts would not be appropriate for models of explicit or historical instruction in the nature of science (Abd-el Khalick et al, 1998). Because, using only such type of textual material, there would be few opportunities to link process of production of knowledge in cultural or historical contexts (Brickhouse, 2001).

According to Ford (2006), in some public and many educational circles this is thought that everyone can do science, or that anyone who acts like a scientist is a scientist to encourage children to take on the identity of a scientist. This motivates the children as well as teachers to maintain their interest in science, and allow them to think of themselves as able to engage in scientific activity (O'Neill & Polman, 2004). In the examined textbooks, one thing was evident that there was little opportunity for children to learn science by doing. In these books, science methods provide few chances to involve children in science activity. Therefore, it would be difficult for children to fully comprehend and understand 'science'.

One of the chief characteristics of the textbooks should be that they convey a sense of appreciation and awe of the beauty of the natural world; they should be visually appealing and use the familiar children's literature tools of art, poetry, and narrative to engage them in natural phenomena (Ford, 2006). The artistic and aesthetic science knowledge blended with familiar and narrative form was found more

frequently in the art books as compared to science books. Narrative mode of representation of science knowledge was better depicted in the earlier classes, for example, class I. One thing was appreciable that stories of science told in these books were through traditional yet rich in detail and context.

Regarding the space covered with the science concepts in analyzed textbooks, results revealed that the majority of science concepts are represented in the early classes i.e., class I and least in the class V. The results show a gradual trend of low representation of science concepts from lower to higher classes. Surprisingly, the most prevalent science concepts were found in the course books of Urdu. This was also supported by the results in table 14, that the analyzed textbooks of class I did better in terms of depicting all types of images related to science concepts. The results showed most frequent concepts are related to figurative images (FI) from all the examined textbooks. FI indicated concepts comprising photos, pictures, and drawings etc.

The science concepts represented in the textbooks were analyzed against the 'levels of content'. Results showed that seven different themes emerged out of the contents of the science concepts. Table 14 indicated (LC 1) that most of the science concepts were indicated on pages (or spaces covered) in the forms of diagrams or in the title of the chapters etc. LC 1 (indication in title or diagram for science concepts) was represented quite adequately in the textbooks of class I (46), class III (21), and class V (12) respectively. On the contrary LC 0 (no evidence of science concepts) was higher in the textbooks of class V (18), class III (8), and least in the class I (7). The

textbooks of class I also provided fairly complete and concise summaries of natural phenomena (see LC 2 in Table 15).

Finally, after viewing the results, this was analyzed that none of the examined textbooks either did not address or inadequately addressed the different types of science knowledge. Overall, these textbooks continued to explicitly or implicitly convey naive representations of the science knowledge.

Study 2

The Main Study

This study was the replica of the *Interview Analyses* done in pilot study (Phase II, Step IV).

Table 15

Demographic Information Related to Types of Schools and Classes of the Children

Schools	Class I		Class III		Class V		Total
	Boys	Girls	Boys	Girls	Boys	Girls	
1. ICG	_	1		1	_	1	3
2. ICB	1	_	1	_	1	_	3
3. IMCG	_	1	_	1	_	1	3
4. IMCB	1	_	1	_	1	_	3
5. FG (Rural)	1	1	1	1	1	1	6
6. FG (Urban)	1	1	1	1	1	1	6
Total	4	4	4	4	4	4	
Grand Total	8		8		8		24

Table 15 shows basic demographic information about the sample of schools and those of the interviewed children for the main study. There were total 24 children who participated in this study. There were 12 girls and 12 boys each. The school sample was representative of all types, administered at federal level.

Table 16

Categories of Questions, Sources of Information, and Related Frequencies from Children's Responses

Categories of questions related with the understanding of the phenomena of the moon	Categories of possible sources of information	Frequencies of responses within category of questions related with the understanding of the phenomena of the moon
1. Direction (position) related concepts	(a) Personal perception & observation of the phenomenon	(a) *f*=12 (c) *f*=2
2. Appearance (visibility) of the moon	(b) Religious teachings & Allah (God)	(b) *f*=3 (f) *f*=1 (h) *f* =1 (a) *f*=12 (c) *f*=2 (d) *f*=2 (i) *f*=1
3. Movement/walk related understanding	(c) Class Teacher	(e) *f*=1 (b) *f*=2 (g) *f*=1 (a) *f*=10 (d) *f*=2
4. Moon as a living object	(d) Parents	(g) *f*=1 (a) *f*=13 (c) *f*=1 (d) *f*=5 (f) *f*=2 (i) *f*=2
5. How many moons	(e) T.V.	(d) *f*=2 (a) *f*=8 (i) *f*=1
6. Origin of the moon	(f) Curriculum related books	(b) *f*=1 (i) *f*=1 (a) *f*=1
7. Beginning of the moon	(g) Parents & Teachers	(d) *f*=1
8. Emergence of the moon	(h) Artifacts, Magazines, Newspapers, & Story Books	(h) *f*=1 (b) *f*=4 (c) *f*=3 (a) *f*=10 (i) *f*=1 (i) *f*=2 (f) *f*=1
9. Disappearance of the moon	(i) Siblings	(i) *f*=2 (a) *f*=11
10. Story related to moon	(k) Peers	(h) *f*=2 (c) *f*=1 (i) *f*=1 (g) *f*=1 (d) *f*=2

Note. (a)=77, (b)=10, (c)=09, (d)=14, (e)=1, (f)=4, (g)=3, (h)=4, (i)=11, (k)=0

Table 16 shows categories of possible sources of information on one hand against the categories of questions related to the understanding of the moon. The third column shows the frequencies of children's responses regarding their understanding of the moon concepts with respect to their personal Perception and Observations (a)=77. The most common responses were related to personal Perception and Observation of the phenomena, whereas, the least common responses were related to Peers (k)=0, T.V.

(e)=1, Parents & Teachers (g)=3, Artifacts, Magazines, Newspapers, & Story Books (h)=4.

Table 17

Frequencies of Important Scientific and Non-scientific Conceptions of the Moon, According to the Responses Class Wise from the Children

Categories of questions	Class I		Class III		Class V	
	S	*NS*	*S*	*NS*	*S*	*NS*
1. Direction (position) related concepts		7(2,4,5, 5,6,6,1)	5(6,2,3, 4)	1(5)	3(3,1,1)	4(5,4)
2. Appearance (visibility) of the moon	7(2,4,3, 5,5,6,6)	2(6,1)	4(6,2,1, 4)	1(5)	3(3,5,5)	2(4)
3. Movement/walk related understanding	1(5)	6(4,3,5, 5,6,6)	2(2,1)	11(6,5, 2,3,3,4)	5(3,2,1, 4)	13(6,2, 5,5,1,1, 1,1,4,4, 4,4)
4. Moon as a living object	1(3)	8(2,4,5, 5,6,6,1, 1)		7(6,5,2, 1,4)	4(3,5,1)	4(2,5,4)
5. How many moons	6(2,5,5, 6,6,1)	2(4,3)	7(5,2,3, 1,4)	1(6)	8(3,2,5, 5,1,4)	1(5)
6. Origin of the moon		1(3)			1(3)	1(3)
7. Beginning of the moon						
8. Emergence of the moon	1(5)	6(2,4,3, 6,1,1)	3(5,3)	4(2,1,4)	4(3,5,1)	3(5,4)
9. Disappearance of the moon		7(2,4,3, 5,6,6,1)	1(5)	6(6,2,1, 4)	1(1)	5(3,5,5, 1)
10. Story related to moon		2(4,6)		1(2)		3(3,1,4)
Total	16	41	22	32	28	36

Note. S = Scientific, NS = Non-Scientific; numbers in ( ) represents the types of schools of the children.

Table 17 indicates high frequency of misunderstanding of scientific phenomenon of moon among the children of class I (41+32+36=109). The table also shows that most of the unscientific concepts are associated with Movement/walk (6+11+13=30), Moon as living object (8+7+4=19), Disappearance of the moon (7+6+5=18), and Emergence of the moon (6+4+3=13), and Direction (position) related concepts (7+1+4=12). However, most of the scientific concepts are associated with the questions: How many moons (6+7+8=21) and Appearance (visibility) of the moon (7+4+3=14), and Emergence of the moon (1+3+4=8).

Table 18

Frequencies of Important Scientific and Non-scientific Conceptions of the Moon, According to the Gender Wise Responses of the Children of Classes I, III, & V

Categories of questions	Boys		Girls	
	Scientific	Non-Scientific	Scientific	Non-Scientific
1. Direction (position) related concepts	4(6,2,2,4)	6(2,4,5,5,5,4)	7(3,3,5,1,1)	4(6,6,1)
2. Appearance (visibility) of the moon	8(6,5,2,2,2, 4,5,4)	2(5,4)	8(3,3,5,5,5, 6,6,1)	2(6,1)
3. Movement/walk related understanding	5(2,2,5,4,4)	14(4,6,6,5,2,2,5 ,6,4,4,4,4,4)	6(3,1,1)	15(3,3,3,5,5,5,6 ,1,1,1,1)
4. Moon as a living object	2(6,5)	9(6,5,2,2,2,4,5, 6,4,4)	3(3,3,3)	8(5,5,6,1,1)
5. How many moons	10(2,2,5,6,2 ,5,5,6,4)	3(4,6,5)	10(3,3,5,6,1 ,1,4)	2(3,5)
6. Origin of the moon				3(3)
7. Beginning of the moon				
8. Emergence of the moon	4(6,5,5)	6(2,4,2,6,4,4)	5(3,3,5,1)	6(3,5,1,1)
9. Disappearance of the moon		9(2,4,6,5,2,5,6, 4,4)	1(1)	10(3,3,5,5,6,1,1)
10. Story related to moon		3(4,2,4)		3(3,6,1)
Total	33	52	40	53

Table 18 shows the overall trend of misunderstanding of the moon concepts is prevalent both in the boys and girls equally. The results also show the understanding of scientific phenomenon of moon in all three classes is slightly higher among the girls (40). The results show the unscientific concepts are associated with Movement/walk related understanding (14+15=29), Disappearance of the moon (9+10=19), Moon as a living object (9+8=17), Emergence of the moon (6+6=12), and Direction (position) related concepts (6+4=10). However, most of the scientific concepts are associated with the questions: How many moons (10+10=20), Appearance (visibility) of the moon (8+8=16), Direction (position) related concepts (4+7=11), Movement/walk related understanding (5+6=11), and Emergence of the moon (4+5=9).

Table19

Frequencies of Important Scientific and Non-scientific Conceptions of the Moon, According Gender Wise Responses of the Children of Class I

Categories of questions	Boys		Girls	
	Scientific	Non-Scientific	Scientific	Non-Scientific
1. Direction (position) related concepts		2(2,4,5)	1(5)	3(6,6,1)
2. Appearance (visibility) of the moon	2(2,4,5)		4(3,5,6,6)	2(6,1)
3. Movement/walk related understanding	1(5)	3(4,5,6)		4(3,5,6,1)
4. Moon as a living object		4(2,4,5,6)	1(3)	3(5,6,1)
5. How many moons	3(2,5,6)	1(4)	2(5,6)	1(3)
6. Origin of the moon				1(3)
7. Beginning of the moon				
8. Emergence of the moon		3(2,4,6)	1(5)	2(3,1)
9. Disappearance of the moon		3(2,4,6)		4(3,5,6,1)
10. Story related to moon		1(4)		1(6)
Total	6	17	9	21

Table 19 shows the high frequency of misconceptions of scientific understanding of moon among girls of class I. The unscientific concepts are associated with Movement/walk related understanding (3+4=7), Moon as a living object (4+3=7), and Disappearance of the moon (3+4=7). However, most of the scientific concepts are associated with Appearance (visibility) of the moon (2+4=6) and How many moons (3+2=5).

Table 20

Frequencies of Important Scientific and Non-scientific Conceptions of the Moon, According Gender Wise Responses of the Children of Class III

Categories of questions	Boys		Girls	
	Scientific	Non-Scientific	Scientific	Non-Scientific
1. Direction (position) related concepts	2(6,4)	1(5)	3(3)	
2. Appearance (visibility) of the moon	3(6,5,4)	1(5)	1(1)	
3. Movement/walk related understanding	1(2)	5(6,5,2,4,4)	1(1)	6(3,3)
4. Moon as a living object		4(6,5,2,4)		3(1)
5. How many moons	3(5,2,4)	1(6)	4(3,1)	
6. Origin of the moon				
7. Beginning of the moon				
8. Emergence of the moon	1(5)	2(2,4)	2(3)	2(1)
9. Disappearance of the moon		4(6,5,2,4)		3(1)
10. Story related to moon		1(2)		
Total	10	19	11	14

Table 20 shows the high frequency of misconceptions of scientific understanding of moon among boys of class III. The unscientific concepts are associated with Movement/walk related understanding (5+6=11), Moon as a living object (4+3=7), and Disappearance of the moon (4+3=7). However, most of the scientific concepts are associated with the questions: How many moons (3+4=7), Direction (position) related concepts (2+3=5), and Appearance (visibility) of the moon (3+1=4).

Table 21

Frequencies of Important Scientific and Non-scientific Conceptions of the Moon, According Gender Wise Responses of the Children of Class V

Categories of questions	Boys		Girls	
	Scientific	Non-Scientific	Scientific	Non-Scientific
1. Direction (position) related concepts	2(4)	1(5)	3(3,1,1)	2(6)
2. Appearance (visibility) of the moon	2(2,4)	1	3(3,5,5)	1
3. Movement/walk related understanding	3(2,4,4)	5(2,5,4,4,4)	4(3,1)	7(6,5,1,1,1,1)
4. Moon as a living object	2(6,5)	2(2,4)	2(3,1)	2(5)
5. How many moons	5(6,2,5,4)	1(5)	4(3,5,1)	
6. Origin of the moon	1			2
7. Beginning of the moon	1			1
8. Emergence of the moon	3(6,5,4)	1	2(3,1)	2(5)
9. Disappearance of the moon		2(5,4)	1(1)	3(3,5)
10. Story related to moon		2(4)		2(3,1)
Total	19	15	19	22

Table 21 shows the relatively high frequency of misconceptions of scientific understanding of moon among girls of class V. The unscientific concepts are associated with Movement/walk related understanding (5+7=12), Disappearance of the moon (2+3=5), Moon as a living object (2+2=4), and Story related to moon (2+2=4). However, the most understood scientific concepts are associated with How many moons (5+4=9), Movement/walk related understanding (3+4=7), Direction (position) related concepts (2+3=5), Appearance (visibility) of the moon (2+3=5).

Table 22

Frequencies of Responses and Sample Statements of Specific (Mis) Conceptions about Moon, Explained By the Children in Interviews

Types of questions pertaining conceptual understandings	Sample statement of interviewee's misconception (s)	Frequencies	Sample statement of interviewee's conception (s)	Frequencies
Have you ever been for a walk or drive outside at night? [If yes]	*No..*(Saba, III.1, Areej, I.1)	2	*...yes…there are stars and ...moon in the sky..* (Uzair, I. 2. Ahmed, I. 4, Umer Sultan, V.5, Basit Ishtiaq, III.4)*….yes…there are stars… moon in the sky*. (Afrasyab,V.2., Kifatullah, III.5., Hasnain, III.6., Ahmed Abbas, III.2)	8
			In the sky..(Fatima, I. 3, Mehwish Aziz, V.5, Rohail, I.6, Tania, I.6)	4
			In East side (Adeena, III. 3)	4
			Yes..(Maryam Kanwal, V.1, Hamza Rafiq, V. 4)	1
				1
Where was the moon? Or Was moon in the sky?	*…it is near to Allah* (Kifatullah, III.5)*...this way…strait..right side*…(Uzair, I. 2)	1	*A little up from the clouds..but not in the sky..because no one can reach the sky…but through 'rocket' one can reach 'moon'moon in the sky*. (Afrasyab,V.2)*.....up there in the sky…towards 'Maghreb'(West)* (Hina, V. 3., Shahzaib, V, Maryam Kanwal, V.1)*Up there on top..*(Nauman Waheed, I,5)	3
	upward (Ahmed, I. 4 Areej, I.1)	2		1
	in North (Shazaib, V)*in South* (Umer Sultan, V.5)	1		5
		1		1
			up there in the sky.. (Iqra. I, 5)	1
			in the sky.. (Hamza Rafiq, V. 4)	1

Continued…

Types of questions pertaining conceptual understandings	Sample statement of interviewee's misconception (s)	Frequencies	Sample statement of interviewee's conception (s)	Frequencies
Can you tell me anything about it? [if no]	*There is sand on it..every where..there is no house ..nothing to eat..*(Afrasyab,V.2). *No..Know nothing...*(Uzair, I. 2, Ahmed, I. 4, Fatima, I. 3, Adeena, III. 3, Rohail, I.6, Saba, III.1, Areej, I.1)..*There are mountains..oceans..rivers..and sand areas or fields..*(Ahmed Abbas, III.2) *Its round..* (Nauman Waheed, I,5) *Nothing special..* (Umer Sultan, V.5) *After 14 the moon becomes sun..it is highly illuminated..Sometimes it becomes very thin..and it becomes thin like a hair on its day..and its light is very much..we take advantage from it..*(Hamza Rafiq, V. 4)	1 7 1 1 1 1	*Astronomical object*…and get light (Hina, V. 3) *Moon gives us light..and we pray for it..because it gives us light"Oh God give us moon light" father told me* (Iqra. I, 5) *When we walk it seems that the moon is also walking beside us.. ..when clouds come..moon hides behind the clouds..then we cannot see it..*(Mehwish Aziz, V.5) *We have light from it..and darkness also..* (Tania, I.6) *This is an astronomical object..this emerges from the West and sets in the East..first of all America touched it..Moon is smaller as compared to the stars..*(Maryam Kanwal, V.1) *Sometimes it is half..and some day it is full..it gives light also...* (Basit Ishtiaq, III.4)	1 1 1 1 1 1

Continued…

Types of questions pertaining conceptual understandings	Sample statement of interviewee's misconception (s)	Frequencies	Sample statement of interviewee's conception (s)	Frequencies
Did you notice anything about it? [if no]	*There is yellow in it…my aunt says..this is house of the 'fairies'* (Afrasyab,V.2). .	1	*It was the part of Earth..there are Mountains on it.and..sand..*(Maira, V)	1
	No… (Hasnain, III.6,).*it is behind the trees* (Kifatullah, III.5)..	1	*.No..its look like…but really not...*(Maira, V Hina, V. 3)	2
	No…(Uzair, I. 2, Ahmed, I. 4, Fatima, I. 3, Adeena, III. 3, Rohail, I.6, Saba, III.1 Areej, I.1, Maryam Kanwal, V.1)	1 8	*but ..don't know.why.* (Hina, V. 3) *…its white* (Hasnain, III.6)…	2 1
	Fairies live on it..my brother told me (Iqra. I, 5) *looks like dots are there..somebody is sitting in it..like a women..eating meal* (Umer Sultan, V.5)*Star..this is itself a star..my father told me..*(Tania, I.6)	1 1		
	Not in the moon..but in the sun..it looks me like a ball..just the shape of the earth.. (Hamza Rafiq, V. 4)	1 1		

Continued…

Types of questions pertaining conceptual understandings	Sample statement of interviewee's misconception (s)	Frequencies	Sample statement of interviewee's conception (s)	Frequencies
Did it look like moving…?	*.yes…it walks….and move* (Ahmed, I.4 ., Shahzaib, V., Ahmed Abbas,III. 2, Fatima, I. 3, Adeena, III. 3, Iqra. I, 5, Umer Sultan, V.5)….*yes…it walks…ahead of us…walks briskly* (Kifatullah, III.5., Hasnain, III.6).	11	*Yes looks..but actually clouds travel..and it seems as moon is walking..* ..(Afrasyab,V.2) .	1
	It walks a little bit.. Mehwish Aziz, V.5)	2	*No*…(Shahzaib, V)	1
	Yes.. (Rohail, I.6, Saba, III.1, Maryam Kanwal, V.1)	1	*Does not walk..remains at one point..*(Nauman Waheed, I,5)	1
	Yes it walks slowly..(Tania, I.6)	3	*No..dont know why..* (Areej, I.1)	1
	Yes..while going to market in riksha (Taxi)..and while walking.I feel the moon and sun is following me. .(Hamza Rafiq, V. 4) *Yes..in the night.. it walks beside us..(*Basit Ishtiaq, III.4)	1 1		
How does that happen?	*Don't know* (Kifatullah, III.5 Ahmed, I. 4., Ahmed Abbas, III. 2 Iqra. I, 5 Mehwish Aziz, V.5,Tania, I.6, Areej, I.1, Basit Ishtiaq, III.4)..*due to gravitational pull* .(Shazaib, V)…*because the moon is so big*..(Maira, V)	8 2	… *don't know..* (Shahzaib, V)	2
	Allah does so.. I know this (Fatima, I. 3)	1	*but moon does not walk….it look like as walking..* (Hina, V. 3) *Actually it does not walk..remains at one point..but I don't know why..(Saba, III.1)*	1 1
	We all watch it walking.. it seems to every one that it is walking (Adeena, III. 3)	1	*It is standing at one point…human eyes deceives…sometimes they deceive some time not.. eyes show different..sometimes…* (Maryam Kanwal, V.1)	1
	The Earth goes there (Umer Sultan, V.5)	1	*This is not the moon…this is world (earth) that is rotating..*(Hamza Rafiq, V. 4)	1
	Because it gives us light in night.. (Rohail, I.6)	1		
Can it follow you? [if yes]	*..yes…it does.. so* (Hina, V. 3, Ahmed, I.4 Adeena, III. 3 Iqra. I, 5, Mehwish Aziz, V.5) *..yes…it does so* (Hasnain, III.6., Kifatullah, III.5., Afrasyab,V.2, Rohail, I.6, Tania, I.6,Hamza Rafiq, V. 4)*It walks somewhere else..I walk here..it walks somewhere else..*(Fatima, I. 3)	9 6 1	*No....*(Nauman Waheed, I,5, Areej, I.1, Basit Ishtiaq, III.4)	3
	It walks ahead of us..(Umer Sultan, V.5)	1		
	At times..(Maryam Kanwal, V.1)	1		

Continued…

Types of questions pertaining conceptual understandings	Sample statement of interviewee's misconception (s)	Frequencies	Sample statement of interviewee's conception (s)	Frequencies
Why does it do that? [Or if no] Why not?	*...don't know..that desires to walk along with me..*(Iqra, III, Hina, V. 3, Ahmed, I.4)*...don't know…* (Hasnain, III.6., Kifatullah, III.5 Rohail, I.6, Tania, I.6).*Allah orders it..to go and come in time..if it is late by even one second.every thing will destroy..*(Afrasyab,V.2) *Allah does so..Allah brings it there..*(Fatima, I. 3) *There is a day on this side..and night on this side..this walks that way and thus night comes..and sun comes to this way..so here comes day..* (Mehwish Aziz, V.5) *It does because our eyes deceive us..and whenever eyes don't deceive..and we stop walking..then it seems it is not walking..*(Maryam Kanwal, V.1) *I have read in my English book..there was a chapter 'The same and different'..I have read in it..this was written in it…if we will stand close..the thing will look bigl..if we will stand far..the thing will look small..if we enter in a tunnel..the thing in front will look big..when we will enter inside..the other pole will look us small..whereas, these two are equal..*(Maryam Kanwal, V.1) *As Allah will desire..it will walk…*(Basit Ishtiaq, III.4)	6 4 1 1 1 1 1 1	*Don't know....*(Nauman Waheed, I,5 Saba, III.1)	2
Has anyone else talked to you about these things? [if yes] What did they say about it?	*.. No…..*(Uzair, I. 2, Ahmed, I.4 Adeena, III. 3, Nauman Waheed, I,5, Umer Sultan, V.5 Mehwish Aziz, V.5, Rohail, I.6, Tania, I.6 Saba, III.1, Areej, I.1, Hamza Rafiq, V. 4) *. My mother tells about the moon..she says this is due to Allah..that moon comes in time and sets in time..just like the sun..*(Afrasyab,V.2).. *.yes..* (Kifatullah, III.5, Hasnain, III.6).*Yes..my father..there are oceans and rivers on the moon..* (Ahmed Abbas,III. 2) *My mama tells about..and I watch T.V..* *Once I saw on T.V..few people were going on the moon..in a rocket..* (Maryam Kanwal, V.1)	10 1 2 1 1	*The moon has not its own light..sun gives the light to the moon.* (Ahmed Abbas,III. 2)	1

Continued…

Types of questions pertaining conceptual understandings	Sample statement of interviewee's misconception (s)	Frequencies	Sample statement of interviewee's conception (s)	Frequencies
[If child says that moon can follow you] Can it follow two people at a time? [if yes] Tell me more about that. [If no] why not?	*No…only with you…*(Rahela, III)	1	*No..it will not walk with two persons.* (Ahmed Abbas,III. 2)	1
	Yes…it seems as walk with two persons (Hina, V. 3, Ahmed, I.4, Mehwish Aziz, V.5, Hamza Rafiq, V. 4)	4	*No..but I don't know why..*(Saba, III.1, Areej, I.1)	2
	It will walk with only you..(Hasnain, III.6).	1		
	Yes…it can walk with two persons… (Kifatullah, III.5, Adeena, III. 3, Iqra. I, 5, Rohail, I.6, Tania, I.6)	5		
	If the two cars are going together..then this will walk alongwith them..(Maryam Kanwal, V.1)	1		
	Some time it will follow you and some time will follow me… (Basit Ishtiaq, III.4)	1		
What if you went this way [pointing one direction] and I went that way [pointing the opposite direction]. Which one of us would it follow? Why?	*Both of us...*(Kifatullah, III.5)	2		
	Only with one person…not with me …with..you.(Iqra, III, Ahmed, I.4)	3		
	With you only..I don't know why (Adeena, III. 3)	1		
	Walks only with one person..if both will walk then it will walk with both..otherwise it will walk with one.. (Iqra. I, 5)	1		
	Both of us will feel that it is walking with us..don't know why.(Umer Sultan, V.5)	1		
	Both of us..because..sky is one..and moon is also one.. that is why everybody feels that is walking.. (Mehwish Aziz, V.5)	1		
	Both of us..but I don't know why.. (Rohail, I.6)	1		
	With you…walk with everyone.. (Tania, I.6)	1		
	This will go with that whose eyes will deceive him..due to our eyes.. (Maryam Kanwal, V.1)	1		
	Both of us feel that it is walking with us.. (Hamza Rafiq, V. 4)	1		

Continued…

Types of questions pertaining conceptual understandings	Sample statement of interviewee's misconception (s)	Frequencies	Sample statement of interviewee's conception (s)	Frequencies
Is the moon alive? How do you know that?	*..yes..because ..it walks*…(Iqra, III, Ahmed, I.4 Ahmed Abbas,III. 2) *Can go from one place to another* (Rahela, III). *Because no one can reach to sky…so it can't die...*….(Uzair, I. 2)*..yes..because ..it walks*…..(Hasnain, III.6 Kifatullah, III.5.,Afrasyab,V.2) *..it goes to give light to other countries..like Canada and America…I don't know..* (Adeena, III. 3) *Yes.. I don't know*.(Nauman Waheed, I,5) *Yes..because it always keeps on moving.. and I know it* ..(Iqra. I, 5) *Yes..because it can move by itself* (Mehwish Aziz, V.5) *Yes..I see it in the night..* (Rohail, I.6) *Yes..my father told me..* (Tania, I.6 Areej, I.1) *Yes..my elder sister told me..*, (Saba, III.1) *Yes..it is alive..because it gives us light..and provides many things..for example..if there would not have been moon..how we would come to know that today is a Eid day..and some times..it becomes so big..and thin,, as on Eid day..then become big..it becomes thin because..we come to know that it is Eid day ..and it is so big..we come to know today is not an Eid day..then..it goes on increasing..it becomes full round..then it becomes sun..* (Hamza Rafiq, V. 4) *Yes..can walk..can stop..and ..give light* (Basit Ishtiaq, III.4)	6 1 1 3 1 1 1 1 1 2 1 1 1	*..No its not alive*…(Hina, V., Shahzaib, V,..(Fatima, I. 3, Maryam Kanwal, V.1) *..it has no eyes..no nose,,no lips,,no teeth,,no neck,,also no hands and arms..* (Fatima, I. 3) *No..because it does not move...*(Umer Sultan, V.5)	5 1 1

Continued…

Types of questions pertaining conceptual understandings	Sample statement of interviewee's misconception (s)	Frequencies	Sample statement of interviewee's conception (s)	Frequencies
Is there more than one moon? [if yes]	*…yes…*(Ahmed, I.4., Hasnain, III.6. Fatima, I. 3)	3	*No..its one because sun is also one..*(Hina, V, Nauman Waheed, I,5)	2
	No ..one....(after the arguments with the interviewer, he said there are three moons).(Umer Sultan, V.5)	1	*one..* (Kifatullah, III.5, Adeena, III. 3, Iqra. I, 5, Afrasyab,V.2, Basit Ishtiaq, III.4).*because there would be light every where..* (Shahzaib, V) *one..because..it was the part of Earth..half piece broke..and it was called moon* (Ahmed Abbas,III. 2)	5 2
			it is one (Mehwish Aziz, V.5 Areej, I.1)	2
			One.. Allah has made it one.. (Tania, I.6, Maryam Kanwal, V.1)	2
How many moons are there? How do you now?	*..so many…in India, Newzealand, Australia.. by myself…the roles..and moon also roles..we ..play..that is why I know* (Ahmed, I.4)*..two…one is yellow and the other is green.*(Hasnain, III.6).*I have seen Two..the other walks with another car* (Fatima, I. 3)	1 1 1	*one.* (Maira, V. Iqra, Rahela, III. Uzair, I. 2 Adeena, III. 3)	5
			..Teacher…told me…(Iqra, III)*One.. I don't know.*(Nauman Waheed, I,5, Rohail, I.6, Saba, III.1)	1 3
	one..looks one….three one is full,,second is skinny,,third is bigger than this...(Umer Sultan, V.5)	1	*One..because..otherwise..there would have been much light in this world..and due to that there would have been much heat in this world..if it there would two or more than two moons…there would be much light and heat in this world..that no human beings could live on this earth..*(Hamza Rafiq, V. 4)	1
			God desired so..(Basit Ishtiaq, III.4)	1

Continued…

Types of questions pertaining conceptual understandings	Sample statement of interviewee's misconception (s)	Frequencies	Sample statement of interviewee's conception (s)	Frequencies
How did the moon begin? Do you have any idea?	*I don't know..*(Rahela, III Hasnain, III.6, Nauman Waheed, I,5 Saba, III.1)	4	*…from the East…*(Shahzaib, V, Afrasyab,V.2)*From the West..* (Kifatullah, III.5)	2
	..from the sky (Hina, V, Basit Ishtiaq, III.4)*..from the clouds …*(Ahmed, I.4)	2 1	*.…from the sky…*(Iqra, III)*…from West (Maghreb)* (Maira, V)*…when the sunsets…from the sky..*(Uzair, I)	5
	…the sun will go to other countries to give light..and the moon will come here.. it is Allah's miracle (Afrasyab,V.2)	1	*When the sun light vanishes..from the downward side of sky..I have see it..my father sent me a children movie (Baby Bay out))..I saw in it that moon was emerging from the downward side..* (Adeena, III. 3)	1
	From the mountains (Ahmed Abbas, III. 2)	1	*It emerges from the right hand side (West)..we call it 'Kaaba' and sets in left hand side (East)..I know it..* (Iqra. I, 5)	1
	When the clouds are black..Then it emerges. Allah sends it..Allah got it..I know it by myself.. (Fatima, I. 3)	1	*When the sun sets.. its light reflects on the moon..so it lits…it seems as it is bright.....it emerges from the sky..I have read in a book* (Umer Sultan, V.5)	1
	When in other countries the sun comes..then the moon comes here..and it emerges from the East..class teachers tell (Mehwish Aziz, V.5)	1	*When the sun sets…it emerges from the 'Maghreb'..West..*(Maryam Kanwal, V.1)	1
	In the evening..moon..emerges..in the night..when the people..are home..no person in the street..then it emerges.. I know it..(Rohail, I.6)	1		
	From the East.. in the school I was told..Allah orders it..(Tania, I.6)	1		
	In the morning..it is in the sky.. (Areej, I.1)	1		
	Due to the Allah's system..I have by myself..and most of the time our teachers also explain..when I was child and studied in KG, or class I and II, my teachers used to tell us..that moon rises from the East and sets in the West (Hamza Rafiq, V. 4)	1		
	I can see in the evening.. (Basit Ishtiaq, III.4)	1		

Contiued…

Types of questions pertaining conceptual understandings	Sample statement of interviewee's misconception (s)	Frequencies	Sample statement of interviewee's conception (s)	Frequencies
Where does the moon go when you can't see it?	*Goes to some other's house,, other's roof* (Iqra, III)	1	*Earth comes in its front…then it hides behind the Earth..* (Maryam Kanwal, V.1)	1
	.hides in cloud…(Hina, V. Uzair, I. 2 Afrasyab,V.2,Hamza Rafiq, V. 4)	4		
	Goes behind the mountains…(Maira, V)	1		
	Goes to West (Maghreb) (Rahela, III)	1		
	It hides in the skies..(Ahmed, I.4) *goes inside the sky..*(Hasnain, III.6)	2		
	behind the clouds.. (Kifatullah, III.5)	1		
	comes over the clouds..(Ahmed Abbas,III. 2)	1		
	comes under the clouds...(Fatima, I. 3,Umer Sultan, V.5)	2		
	I don't know. . (Adeena, III. 3, Nauman Waheed, I,5 Areej, I.1)	3		
	It goes far away..hides itself..behind the 'Kaaba' (Iqra. I, 5)	1		
	It goes to the other countries.. (Mehwish Aziz, V.5 Basit Ishtiaq, III.4)	2		
	After a while..when we wake up in the morning.. it goes suddenly…I don't know goes into the sky.. (Rohail, I.6)	1		
	Goes in the clouds… (Tania, I.6)	1		
	It sets in the sky..(Saba, III.1)	1		
Total		213		102

Note: In ( ) name, class, & school type of the children.

Table 22 shows comprehensive qualitative results of the interviews conducted with the children. Misconceptions or alternative conceptions related frequencies are in greater numbers as compared to the conceptions of the natural phenomena of the moon. The frequencies of misconceptions (213) outnumbered the frequencies associated with conceptions (102) of the moon related concepts. The results show majority of the misunderstood concepts are associated with movement of the moon, moon as a living object, and disappearance of the moon. At the other hand, majority of the children had high frequencies of responses related to more than one moon and visibility of the moon.

Table 23

Frequencies of Children, Who Responded Specific Conceptions of the Moon (Narrative Mode in the form of Stories)

Types of questions pertaining conceptual understandings	Sample statement of interviewee's misconception (s)	Frequencies of the statements	Sample statement of interviewee's conception (s)	Frequencies of the statements
Can you tell me a story about the moon? Or do you know any stories about the moon? Could you make up a story about the moon?	*I … don't know about any story.*(Fatima, I. 3, Nauman Waheed, I,5, Iqra. I, 5, Umer Sultan, V.5,Mehwish Aziz, V.5, Saba, III.1 Areej, I.1, Basit Ishtiaq, III.4)	13(3, 2,3,5,5,5, 5,6,1,1,4)	*My mom says..that fairies lived here…once the clouds thundered..due to this fairies went to the moon to live..they live in houses..yellow.* (Afrasyab,V.2)	1
	we get light from the moon..Astronomical object…it loves with earth… (Hina, V)	1	*Travelers were traveling..they forgot their way..there were stars..upward.. two stars come*	
	Ahmed started singing a song…containing the poetry of moon…"Chandni raatain." ..(Ahmed, I.4)	1		
	I know a story..but I don't remember it..'Chand ki baity'(daughter of moon)..I read in a story book.. (Adeena, III. 3)	1		

Continued…

Types of questions pertaining conceptual understandings	Sample statement of interviewee's misconception (s)	Frequencies of the statements	Sample statement of interviewee's conception (s)	Frequencies of the statements
	In previous school..madam told a story.."*chanda mamo aa ja,,kio hay chanda ro raha,,chandi ka katora,,saathi tairy taray,,gaendo kay fawary,,ammi baaji kehti hain,,chan pey parian rehti hain,,sab bachay so jaty hain,,parian nechi aati hain" it is a poem..* (Tania, I.6)	1	*down..we should guide them..slowly..t hey come down..one of them was bigger and the other was smaller..one of them asked let guide them..the other one readily accepted the suggestion..the y started telling the way..in the morning,, first star said..now the sun has taken our light..the other star comments,, we have done our job...* (Ahmed Abbas,III)	1
	In the beginning one person tried to go to the moon…but could not go..science has got so much progress..that planes have been manufactured..they fly..they have gone to moon..and helicopters are manufactured..people have reached moon..and have seen the moon..once I asked my elder sister that can we go to moon…because my teacher told that there is sand heaps..there is nothing to eat..my sister told that if we put oxygen..then we can live for a while.. it emerges one night before on Eid day ..and it is very skinny and thin..we can not see with our eyes..we can see it only with microscope..then slowly it enlarges..slowly it becomes sun..then again it become thin slowly..(Hamza Rafiq, V. 4)	1	*My mom told me a story…*"*once upon a time..there were few nightingales..t hey used to live in jungle..there was a moon..clouds cover the moon..they say to each other..look moon has fallen down..dont know where it has gone..we search it..they go forward..they*	

Continued…

Types of questions pertaining conceptual understandings	Sample statement of interviewee's misconception (s)	Frequencies of the statements	Sample statement of interviewee's conception (s)	Frequencies of the statements
			find an egg of a bird...they say that..we will lit this egg..a bat comes around,,, she says no light,,no power,,no power no light..they say we will lit it..they make different designs…but it does not lit..they think that there might be a switch..then they try to find that switch.. after a while their light ends..and they sleep on the leafs..meanwhi le an eagle comes..that sees it was his house..he puts that egg in the nest..after some time..clouds go away..when fire flies wake up..they see..there is moon..they believe we have again brought light to the moon..and till today..they believe we have again made the moon.. " (Maryam Kanwal, V.1)	1

Continued…

Types of questions pertaining conceptual understandings	Sample statement of interviewee's misconception (s)	Frequencies of the statements	Sample statement of interviewee's conception (s)	Frequencies of the statements
That story you just told me …did it really happen? What really happens?	*It is real..fairies live in the moon.. the madam of previous school told.* .(Tania, I.6)	1	*No...stars can not come to the Earth.* (Ahmed Abbas,III)	1
	no..they have not made the moon..Allah has made the moon.. my mom told me..(Maryam Kanwal, V.1)	1		
How do you know?	*teacher told me..I read in newspapers.* (Hina, V)	1		
All questions that I asked you today, and you answered, tell me what really happens? [if yes] How do you know it really does happen? Where did you learn this? [if no] what really does happen?	*..These things are real… And listened the news…there is firing…killings…the persons..in India…one thing is very dangerous…...*(Ahmed, I.4)	1	*No..stars cannot come down..in reality stars are upward..in morning..they hide* (Ahmed Abbas,III)	1
	My teachers and parents told me…all about these things..(Iqra, III)	1		
	On the Pakistani flag..and social science book.. .(Fatima, I. 3)	1		
	Teachers and parents told me..they tell fairies live on the moon.. (Iqra. I, 5)	1		
	Half of the things I knew..and half of the things were told in the school.. (Mehwish Aziz, V.5)	1		
	Yes..all these things are real.. (Rohail, I.6, Tania, I.6)	2		
	In previous school they taught Yes.. (Saba, III.1, Hamza Rafiq, V. 4)	2		
	Yes..some from T.V., some from my mom…some from books..On..picture..shabeB arat..on my book..there is a moon..in story book..of fire flies,,, (Maryam Kanwal, V.1)	1		

Continued…

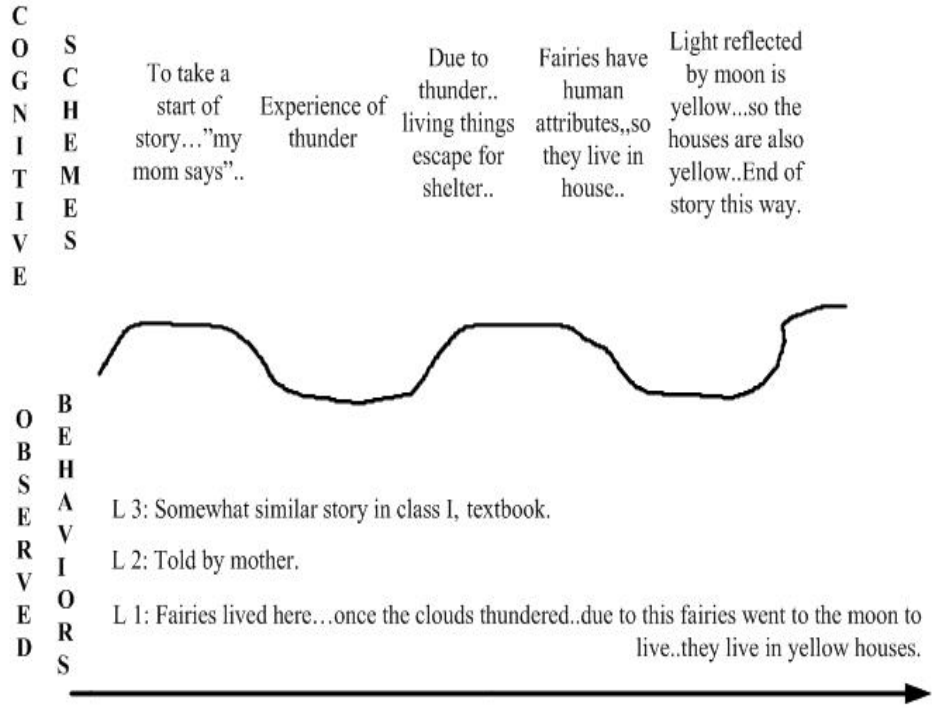
Types of questions pertaining conceptual understandings	Sample statement of interviewee's misconception (s)	Frequencies of the statements	Sample statement of interviewee's conception (s)	Frequencies of the statements
	Teacher told me..(Basit Ishtiaq, III.4)	1		
	When the month of Ramadan comes..we can see moon..(Basit Ishtiaq, III.4)	1		
Total		33		5

Note. In ( ) names, classes, & school types of the children.

Table 23 shows the frequencies related to the responses regarding the story related questions by the children. Most of the children could not make a story about the moon or do not know any story. There were five children who were able to narrate a story. Results also show that religious and cultural factors are more prevalent in narrating and understanding of the concepts.

It was tried to look at children's ideas about the moon as a cognitive scheme (whether they qualify as an organized structure). A similar strategy was adapted as done by Louisell, Kazemek, and Wellik (2007). They used a *wavy line diagrams;* in such diagrams, the observed behavior (e.g., the transcript of the child's words, along with notes about relevant gestures, etc.) is mentioned below the wavy line and the researcher's inferences about what might be going on in the child's mind are put above the wavy line (in much the same way as a "bubble" containing word might represent a person's thoughts in a cartoon).

Different levels were included below in the figures using wavy lines to represent the different kinds of observed behaviors and cognitive schemes of the interviewed children.



Adapted from Louisell, Kazemek, and Wellik (2007).

Figure 7. Afrasyab's Cognitive Schemes (class V).

In Afrasyab's interview, observed behaviors have been shown in three different kinds; his interview remarks, story told by his mother and his probable reading of story from class I, textbook as well (Table 11).

His initial words, "my mother says" (Table 23) represent his concept of how someone tells a story. His second phrase what he has observed "once the clouds thundered", and his third and fourth phrase represents a causal relationship "due to this fairies went to the moon to live" (escape behavior), and he thinks fairies have human like attributes; because, humans live in a house, therefore, fairies should live in

a house and hence, moon is the house of the fairies “they live in yellow houses”. The last phrase of Afrasyab’s story reflects the color scheme of the house, it seems logical, because the light reflected by moon is yellow; therefore, the color of the house is yellow.

Chapter-IV

DISCUSSION, CONCLUSION, & IMPLICATIONS

Discussion

The present research was carried out to explore the phenomenon of children's understanding of science concepts. The study mainly focused the cultural context in the development of concepts. The main objective of this study was to focus its data sources and sample target on primary school education and children studying in primary classes. To explore the children's understanding about the natural phenomena of the moon, an in-depth interview protocol was translated and used for data collection. This interview protocol was initially developed and applied on American children by Louisell, Kazemek, and Wellik (2007). The interview schedule was translated through a standardized procedure including committee approach. The overall study heavily depended on the basis of data collected through this interview schedule. This interview schedule has also been used successfully in another research done by Jennifer Wilhelm (2009). The data collected through this interview schedule showed that this instrument has sufficient psychological properties and it can be used confidently for research purposes. The detailed account has been discussed about this 'interview' in earlier chapters. The data were conducted through interviews and qualitative analyses of course books, newspapers, and T.V programs were carried out to address the research questions of the research.

Two studies were conducted in different phases to complete this research. Study 1 was completed in three phases. In the phase 1 of the study 1, try out was

conducted on three children to assess the suitability of the translated and adapted interview protocol for a broad based study, have an insight into the different themes of children's understanding of moon's concepts, and to identify the prospective sources of future directions of the study.

Phase 2 was completed in four different steps. The main objectives of the phase 2 were to analyze the contents of the interview protocol, to formulate coding schemes for the analyses and interpretation of the interview protocol, and to identify and check out the appropriateness of the categories of responses emerged out of the questions asked to the children. In step 1, pilot study was completed. The important aspect of the pilot study was the interviews with the children. The interviews were conducted on relatively small sample. In the second step of the study, interviews with the parents and teachers were conducted. However, results did not show sufficient proof of parental and teacher support in the development of the science concepts of the children. Therefore, further investigation was dropped in this regard. In the third step of the study, a brief observation of the T.V programs related to the children were carried out to check as the possible sources of transmitting science knowledge in the children. But this is worth mentioning that the researchers were unable to observe and find such a program, which could be analyzed for further scientific investigation as a contributing source of knowledge.

In final and fourth step of the phase 2 of the study, each transcribed interview was analyzed and systematic content analysis identified themes pertaining to understandings of the moon concepts among the children. A list of participant's statements was generated. The list included responses describing common confusions,

misunderstandings or misconceptions related to the phenomena of the moon. The statements from each interview were sorted according to their main messages.

Phase 3 was completed in two steps. During step I, newspaper analysis was done. The main objective of this analysis was to examine the text structure and content about the science concepts presented in the newspapers to determine if the text presented in any form is helpful in the children's understanding of the science concepts. The results showed a very weak link between actual understanding of science concepts and portrayal of science knowledge in the newspapers.

The second step of the phase 3 involved the analysis of textbooks of primary classes. This was an important part of the entire study as it had a great significance and importance regarding the educational as well as psychological perspectives that to what extend knowledge represented in those books is contributory and helpful in the understanding of the science concepts.

Study 2 is comprised of the main study. This part deals with the main objectives of the research. The main objective of this study was to find out the sources of children's concepts of the moon on a larger sample to get a more clear and detailed picture of the phenomena under study.

The main study featured to investigate, discover, and interpret children's understanding about the natural phenomena of the moon. In this way, children's existing conceptions about the phenomena of the moon could be identified and psychologists and educators could use the information to create or modify instruction that better meets the needs of learners.

Research questions were formulated to address the issues discussed above. In the coming sections, three related issues derived from this study, will be discussed.

Children's Understanding about Moon

The main objective of this study was to find out the Pakistani children's conceptions about the natural phenomenon of the moon. Therefore, the first two research questions addressed this particular issue. That deals with the questions what are the children's conceptions about the natural phenomenon of the moon, and in what ways their ideas about moon are consistent or inconsistent with the scientifically accepted perspective? The results indicated understandings about the moon among Pakistani school children are not scientific (Table 17). This means that majority of the Pakistani school children do not hold scientific concept of the moon, rather they have alternative concepts to the scientific concepts. The reason could be that children can enter the educational setting with informal ideas (alternative conceptions) about scientific phenomena; and these ideas affect how the corresponding scientific explanations are learned and interpreted (Windschitl & Andre, 1998). This means that the knowledge gained by the children outside the educational setting is not based on scientific theories and explanations. The previous researches show that some time the children's knowledge may not be compatible with scientific knowledge and scientific worldview (Lee, 1999). The results of this study correspond to a previous study conducted by Stahly, Krockover, and Shepardson (1999). They examined third grades student's ideas about the lunar phases. They concluded that students held scientifically accurate as well inaccurate conceptions.

Overall results showed that both boys and girls hold unscientific conceptions about the moon, so there is no difference regarding the gender (Table 18). Why there is no difference among boys and girls in the understanding of science knowledge,

according to Brotman & Moore (2008), there has not been a systematic, comprehensive review of the literature on gender and science education in recent years. However, in retrospect, if we look at the results, the girls showed more understanding of science concepts of the moon as compared to the boys (Tables 18, 19, & 20). This is supported by several multiple studies like; Catsambis, Greenfield; McEwen, Knipe, & Gallagher; Zohar and Sela, (as cited in Brotman & Moore, 2008) that in terms of achievement, girls achieve in science education at an equal or higher level than boys.

As children of class I are expected to be at pre-conceptual stage as indicated by international as well as Pakistani researches on cognitive development. Therefore, they carry misconception about most of the aspects of moon i.e., non-scientific responses.

More detailed description of the results can be seen in the Table 22. The results showed in this table are good depiction of the actual statements given by the children of all ages, classes, and having a different background of schools. The statements both reflect the conceptions and misconceptions of the understanding of the moon. The frequencies of the results indicated that statements reflecting misconceptions (215) about the moon heavily outnumbered the conceptual statements (102).

Research questions 7 and 8 are related to the psychological and developmental aspect of the study. These questions meant to study the different scientific reasoning and conceptions of the natural phenomenon of moon across the different stages of development as well as from different classes by the children. This aspect of research was part of the design since it is expected in class III and V children will move

towards concrete operational thinking and the fact of class I children indicating pre-conceptual thinking is not a limitation of the study. The results supported the existing psychological theories like Piaget and Vygotsky. Although, as it has already been described that children's conceptions about the moon is poorly acquired, however, these misconceptions are prevalent in early classes like class I (Table 19). The results of this table showed both the boys and girls non-scientific frequencies are 17+21=38; whereas, their scientific frequencies are like this 6+9=15, as compared to the results of classes III (non-scientific; 19+14=33 and scientific; 10+11=21) and V (non-scientific; 15+22=37 and scientific; 19+19=38). That clearly means initially the children hold quite unscientific understandings about the natural phenomenon and gradually, their understanding become more consistent with the scientific explanations. The scientific explanation could be found in the Vygotskian concept of *zone of proximal development*. This asserts that a child learns with the help of other individuals. The child also learns through psychological tools and also artifacts help in the understanding of the concepts. This explanation may also be supported by the Piagetian concepts of *concrete operations stage.* As the children cross the higher developmental stages, their explanations may become more consistent with scientific reasoning. For example, considering the children from class V, presumably, according to Piaget, a child is in concrete operations stage. Where a child in this stage is able to think about existing objects and its properties and a child can perform logical operations.

Overall the results showed a very dismal picture of primary school levels children's ideas about moon. They are not consistent with the scientifically accepted perspective. This entails that science concepts are poorly understood and acquired by

children. Hence, the society and institutions as a whole are not fully transferring and transmitting the knowledge to the children.

Culture, Cultural Artifacts, and Psychological Tools in the Understanding of Concepts about Moon

Several psychologists, academicians, educationists, and researchers like Bourdieu & Passeron; Bourdieu et al; Cole; Gee, Hull, & Lankshear; Lave, and Wenger (as cited in Chinn, 2007) suggest sociocultural theories assume that learning cannot be dissociated from interpersonal interactions located in cultural frameworks.

Considering such strong theoretical assumptions, the present study mainly aimed at focusing on the cultural relevance in the understanding of the science concepts. Four basic but important research questions addressed cultural issues of the study. The foremost question was regarding the cultural relevance in the formation of the children's concepts about the natural phenomena. The overall results of the study supported other studies indicating a strong link in the conceptual understanding and influence of cultural factors. This study also supported the assumption that understanding is a constructive process, in which learners are responsible for their own learning.

Central to this perspective understanding the science concepts are a number of assumptions shared with Vygotskian traditions. Social as well as cultural influences in the conceptual understanding is parallel to the Vygotskian idea of *psychological tools and culturally mediated learning experience,* in which Vygotsky believed that learning takes place as the result of sociocultural mediation. These results are also

supported by the study of Reevels, Kelly, and Duran (2007), who argued that this process involves learning to use psychological tools for constructing understandings that are developed and shared socially. A second shared assumption is related to the *inter-mental psychological abilities* of the child. The term is described as 'within people'. That means inter-mental ability occurs in the relationship between people. The results of the current study showed that understood concepts had clear relationship with social milieu of the child.

An attempt was made to find a relation with different dimensions of young children's natural science concepts as broader framework of epistemological reasoning found in a specific culture. There are clear indications of link between epistemological beliefs and understanding of the concepts (Table 22). The results of the study support the findings of several other studies like; McKloskey & Kargon, Wiser, Vosniadou & Brewer, and Carey & Spelke (as cited in Samarapungavan, Vosniadou, & Brewer, 1996), claim that the process of acquiring knowledge about the physical world as one in which children construct an initial understanding of the observed world based on their everyday experience. Over time, children are exposed to the adult culture's theories of the physical world and must restructure their naive beliefs in way that take the new information consideration.

The results of the study also support the assumption of Samarapungavan, Vosniadou, and Brewer's (1996) comparisons of children's constraints that influence the conceptual development of children's understandings of physical world.

Continuing with the cultural aspect of the study, another basic research question focused and dealt with the specific cultural artifacts in the forms of stories for example, books, television programs, etc, to seek out whether they have any

contribution in the process of thinking and understanding of the concepts. The research findings showed (Tables 11, 12, 13, 14, 16, 23, & figure, 3) sufficient evidences of the role of cultural artifacts in the development of the science concepts conforming to Vygotskian theoretical perspectives.

This is one of the potential socio-cultural constructivist approaches that emphasize the interaction between the agents (children, learner, instructor, and so forth) and their environment (school setting, its artifacts, and cultural practices). In the present study, it is viewed this interaction as a strong principle of mediation as an effective means for understanding the construction of science knowledge in the children.

This is quite evident by the results that culture is a strong source in the acquisition and understanding of science concepts.

Representations of the Scientific Concepts of Moon in the Analyzed Textbooks

According to Rutherford and Ahlgren (as cited in Howes, 1998), in America, National Science Education Standards urge teachers and academicians to select science content, adapt and design curricula to meet the interests, knowledge, understanding, abilities, and experiences of students. To find out what was the situation in Pakistan, a research question was formulated to see the distinguishing features of scientific concepts naturally acquired by children taught to them through school curriculum in Pakistan. The data was analyzed from different aspects.

In general, the analyzed textbooks did not fare well in their representation of the science concepts, particularly the moon.

Conclusion

This study has great significance from educational, psychological, and cultural perspectives. This can be concluded that children are building their understanding of the moon concepts on their personal experiences and observations. Other sources like, textbooks, media, teachers, and parents are contributing at minimal level in the understanding of the concepts. Which shows that educational system as a whole is not contributing effectively in the understanding of the science concepts. The results also show that culture and cultural artifacts are not playing significant role in the development of science concepts. The expectation of children moving towards the concrete operational level is only marginally found because, the culture which includes parents, newspapers, T.V programs, and educational process that includes teachers and textbooks is not supportive to providing of cognitive development of the children. Hence, substantially they remain at pre-operational level with non-scientific explanations.

The findings of this research reflect *Cultural Barrenness* in Pakistan. There are very rare opportunities for the children to familiarize with the concepts of moon. They cannot develop the scientific understanding of the natural world. The material world and institutions which are main sources of transmitting the knowledge to the youth of any nation is not contributing their expected role. The books particularly curriculum-related ones failed to be helpful in the understanding of the concepts. The pictures, space covered, textual as well as contextual material, implicit, and explicit knowledge is not sufficiently geared to promote scientific literacy. Scientific information represented in the textbooks is not promoting thinking process. The

linkage of scientific understanding and textbook material is found to be very weak. That eventually makes the things difficult for the children in the development of conceptual development. Therefore, it is concluded that represented material is creating psychological constraints in the conceptual development of the children in Pakistan.

This is concluded from the results of this research that theory-driven, psychological/social aspects of the scientific enterprise and social and cultural embeddedness of science and other aspects continue to be either misrepresented or at best be neglected in the textbooks.

Most of the children had no access to the other printed material like; newspapers and storybooks as supplements of knowledge construction. Newspapers analysis showed very scanty science material that was not helpful in the conceptual understanding of the children. Pictures, illustrations, diagrams, and other textual as well as contextual materials published in the newspapers of Pakistan also showed very scanty information for the concept development.

Implications of the Study

In the area of concept development with an emphasis on particular cultural aspects, present research may be considered as the pioneering effort. The development of methodology and techniques for analysis of textbooks and to explore the children's ideas through in-depth interviews is a significant contribution in the areas of research and education for children in Pakistan.

As it has already been mentioned that present study had significant implications with regard to psychological, developmental, educational, and academic points of view. Pakistan's educationists and policy makers should develop and design curriculum embedded with social and psychological theories, so that our textbooks really disseminate the knowledge that is psychologically and academically appropriate.

The teacher training programs should be designed in accordance with the existing psychological theories so that they may contribute and transfer the knowledge to the children in the best way.

Our education system needs to be coordinated and integrated with theory into practice.

The implication of the present work can also be seen in the area of the girl education, as this is aspired to improve this component in Pakistani education system. The findings of this research may contribute significantly in helping to improve the role of socialization in understanding and construction of science knowledge.

There is a dire need to look into the whole process of education and other institutions of the society that may contribute in the understanding of science concepts. It is concluded that the implications of the research cover many and varied areas of psychology and education etc.

Limitations and Suggestions

Despite the wide implications of the present research, there is no research without limitations. Here certain limitations are discussed and further research directions are suggested with regard to present research:

1. The present research was a pioneering research in the area of understanding of science concepts of the children with special emphasis on cultural aspects. So, it focused only children of particular classes. In the present study target sample was primary school children. However, as it is known, teachers are an important aspect of teaching and learning processes. It is important to note, whether the teachers themselves have a better understanding of the science knowledge as well as natural world including the phenomena of the moon or not. So, further investigations may be focused on teachers as well. Therefore, to take a more comprehensive account of the whole process of concept and thought development, this is imperative to conduct future research on teachers.
2. This study was conducted in Islamabad and its suburbs. The results may undermine the generalization issues. For a broad based study, it is further suggested to conduct it on a bit larger sample, representing the entire country and subgroups.
3. As the literature suggests, quantitative measures also can be used for the phenomena under study. So, the future data can be collected and analyzed in a quantitative manner to give a blend of qualitative as well as quantitative research.

4. Future research should be directed to investigate folk lore and indigenous knowledge about the natural world of the children.
5. Details of culturally mediated and psychological tools in Pakistani culture those work as constraints in the concept development may be explored for a better understanding of the phenomena.
6. The contribution of this study relates to developmental as well as educational Psychology. However, it has implications in the field of education. It might be helpful to teachers and educational authorities. Hence, it can help to increase the overall educational standards in the country if its findings are implemented.

REFERENCES

Abd-el-Khalick, F., Bell, R. L., & Lederman, N. G. (1998). The nature of science and instructional practice: Making the unnatural natural. *Science Education, 82,* 417-436.

Abell, S., Martini, M., & George, M. (2001). 'That's what scientists have to do': Preservice elementary teachers' conceptions of the nature of science during a moon investigation. *International Journal of Science Education*, *23*(11), 1095-1109.

Adamson, L. B., Foster, M. A., Roark, M. L., & Reed, D. B. (1998). Doing science project: Gender differences during childhood. *Journal of Research in Science Teaching*, *35*(8), 845-857.

Adeeb, A. M. (1996). *The concept of higher education: Comparative study of developed and developing countries*. Multan: Beacon Books.

Ajmal, S. (2003). *My English reader for class III.* Islamabad. National Book Foundation.

Ajmal, S. (2005a). *My English reader for class I.* Islamabad. National Book Foundation.

Ajmal, S. (2005b). *My English reader for class V.* Islamabad. National Book Foundation.

Ajmal, S. (2005c). *Social studies for class V.* Islamabad. National Book Foundation.

Alanis, I. (2007). Developing literacy through culturally relevant texts. Children's literature. *Social Studies and the Young Learner, 20*(1), 29-32.

Anderson, W. C. (2000). Science education in a global age. Editorial. *Journal of Research in Science Teaching*, *37*(1), 1-2.

Anderson, W. C. (2000). Studying student thinking. Preface. *Journal of Research in Science Teaching*, *37*(2), 105-106.

Andrabi, T., Das, P., & Khwaja, I. A. (2002). *The rise of private schooling in Pakistan: Catering to the urban elite or education the rural poor?* Retrieved February 21, 2009, from http://www.economics.pomona.edu/Andrabi/Research/Pakschool%20March29.pdf

Anglin, J. M. (1977). *Word, object, and conceptual development*. New York: Norton.

Anita, C. T. (1998). Opening up the text: Ten books for critical study. *Journal of Children's Literature*, *24*(2), 76-82.

Applebee, N. A. (1978). *Child's concept of story: Ages two to seventeen*. Chicago: The University of Chicago Press.

Asoko, H. (2002). Developing conceptual understanding in primary science. *Cambridge Journal of Education, 32*(2), 153-164.

Ault, C.R. (1984b). Intelligently wrong: Some comments on children's misconceptions. *Science and Children*, 21, 22–24.

Ausubel, D. P. (1968). *Educational psychology: A cognitive view*. New York: Holt, Rinehart and Winston.

Baker, C. D., & Freebody, P. (1989). *Children's first school book: Introductions to the culture of literacy*. Oxford: Basil Blackwell.

Bar, V., Ever, Z., & Zinn, B. (2000). What are the moon's dark areas? *Science Activities*, *36*(4), 20-3.

Baxter, J. (1989). Children's understanding of familiar astronomical events. *International Journal of Science Education, 11*, 502-513.

Bell, B., Brook, A., & Driver, R. (1985). An approach to the documentation of alternative conceptions in school students' written responses. *British Educational Research Journal*, *11*(3), 201-213. Retrieved May 22, 2007, from http://links.jstor.org/sici?sici=0141-1926%281985%2911%3A3%3C201% AAATTDO%3E2.0.CO%3B2-O http://www.jstor.org.

Bell, L. R., & Trundle, C. K. (2008). The use of a computer simulation to promote scientific conceptions of moon phases. *Journal of Research in Science Teaching, 45*(3), 346-372.

Boehm, A. E. (1969). *Manual of Boehm test of basic concepts*. New York: The Psychological Corporation.

Boehm, A. E. (1976). *Teacher's manual: Boehm resource guide for basic concept teaching*. New York: The Psychological Corporation.

Boeree, C. G. (2006). *Personality theories: Jean Piaget.* Retrieved February, 15, 2009, from http://webspace.ship.edu/cgboer/piaget.html

Boissiere, M., Baig, S., Modi, M., & Zafar, F. (2007). *Evaluation of world bank assistance for primary education in Pakistan: A country case study*. Retrieved February 20, 2009, from http://lnweb90.worldbank.org/oed/oeddoclib.nsf/ DocUNIDViewForJavaSearch/AA57B02DD6736EBC85257289007C3EBD/$ file/pakistan_education.pdf

Bowen, A. G. (2005). Preparing a qualitative research-based dissertation: Lesson learned. *The Qualitative Report, 10*(2), 208-222. Retrieve May, 14, 2009 from http://www.nova.edu/ssss/QR/QR10-2/bowen.pdf

Brickhous, N. W. (2001). Embodying science: A feminist perspective on learning. *Journal of Research in Science Teaching, 38,* 282-295.

Brooks, J. G., & Brooks, M. G. (1993). *The case for constructivist classrooms*. Alexandria, VA: Association for Supervision and Curriculum Development.

Brooks, J. G., & Brooks, M. G. (1995). *The case for constructivist classrooms*. Alexandria, VA: Association for Supervision and Curriculum Development.

Brotman, S. J., & Moore, M. F. (2008). Girls and science: A review of four themes in the science education literature. *Journal of Research in Science Teaching, 45*(9), 971-1002.

Bruner, J. (1966). *Toward a theory of instruction*. Cambridge, MA: Harvard University Press.

Bruner, J. (1986). *Actual minds, possible worlds*. Cambridge, MA: Harvard University Press.

Bruner, J. (1990). *Acts of meaning*. Cambridge, MA: Harvard University Press.

Bruner, J. (1996). *The culture of education*. Cambridge, MA: Harvard University Press.

Caduto, M. J., & Bruchac, J. (1994). There's science in that story! *Instructor*, *103*(7), 42-44, 48, 92. Retrieved May 28, 2007, from http://find .galegroup.com/itx/printdoc.do?

Chen, J-Q., Goldsmith, L., & Feldman, H. D. (1994). The crafted world: Children's understanding of the distinction between artifacts and natural objects. *Child Study Journal, 24*(2), 89-105.

Cherry, G. (2004). *An overview of Jerome Bruner, his theory of constructivism*. Retrieved April 18, 2009, from http://www.odu.edu/educ/roverbau/Class_Websites/761_Spring_04/Assets/course_docs/ID_Theory_Reps_Sp04/Bruner-Cherry.pdf

Chinn, P. W. U. (2007). Decolonizing methodologies and indigenous knowledge: The role of culture, place and personal experience in professional development. *Journal of Research in Science Teaching, 44*(9), 1247-1268.

Clark, H. H., & Clark, E. V. (1977). *Psychology and language: An introduction to psycholinguistics*. New York: Harcourt Brace Jovanovich.

Cobern, W. W. (1993). Constructivism. *Journal of Educational and Psychological Consultation, 4*(1), 105-112.

Cohen, D. (1983). *Piaget: Critique and reassessment.* London: Croom Helm.

Cohen, G. (1983). *The psychology of cognition* (2nd ed.). London: Academic Press. England.

Cohen, M. R., & Lucas, K. B. (1999, July). *Lunar shapes and shadows: What are the sources of our instructional ideas*? Paper presented at the 48th annual meeting of the Australian Science Teachers Association, Adelaide, South Australia.

Cole, M. (1996). *Cultural psychology: A once and future discipline*. Cambridge: Harvard University Press.

Cole, M., & Wertsch, V. J. (1996). *Beyond the individual-social antimony in discussions of Piaget and Vygotsky*. Retrieved June 21, 2007, from http://www.archive.org/web/www.massey.ac.nz/~ALock/virtual/colevygotsky

Cooley, K. (2001). *Moon phases.* Retrieved August 23, 2010, from http://home.hiwaay.net/~krcool/Astro/moon/moonphase/

Cummins, H. R., Ritger, D. S., & Myers, A. C. (1992). Using the moon as a tool for discovery-oriented learning. *Journal of Geological Education, 40*(2), 142-46.

de Lima, M. M. T. (1993, July). *The child's view of the world: The origin of moon, sun and stars*. Paper presented at the Biennial Meeting of the International Society for the Study of Behavioural Development, Recife, Brazil.

Denis-Prinzhorn, M., & Jean-Blaise Griz (1976). *The clinical method in education* (M. W. Lousell & R. Easley, Trans.). A paper published by Committee on Culture and Cognition, University of Illinois at Urbana-Champaign.

Denzin, N. K., & Lincoln Y. S. (1994). Entering the field of qualitative research. In N. K. Dentin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 1-17). Thousand Oaks, CA: Sage.

Donaldson, M. J. (1973). *Development of understanding of selected science phenomena in young children*. Unpublished doctoral dissertation. Graduate Council, University of Tennessee.

Dorothy, J. L. (1993, December). *A comparison of third grade children's listening comprehension of scientific information using an information book and an informational storybook*. Paper presented at the 43rd Annual Meeting of the National Reading Conference, Charleston, SC.

Driver, R., & Erickson, G. (1983). Theories-in-action: some theoretical and empirical issues in the study of students' conceptual frameworks in science. *Studies in Science Education*, *10*, 37-60.

Driver, R., Asoko, H., Leach, J., Mortimer, E., & Scott, P. (1994). Constructing scientific knowledge in the classroom. *Educational Researcher*, *23*(7), 5-15.

Ebenezer, V. J., & Connor, S. (1998). *Learning to teach science: A model for the 21st century*. NJ: Prentice-Hall, Inc.

Flanagan, J. O. (1991). *The science of the mind* (2nd ed.). MA: MIT Press.

Ford, J. D. (2006). Representations of science within children's trade books. *Journal of Research in Science Teaching, 43*(2), 214-235.

Fosnot, C.T. (Ed.). (1996). *Constructivism: Theory, perspective, and practice.* New York: Teachers College Press.

Foster, G. W. (1996). Look to the moon. *Science and children*. *34*(3), 30-33.

Garton, A., Pratt, C. (1989). *Learning to be literate: The development of spoken and written language* (2nd ed.) Basil Blackwell. Retrieved April 19, 2009, from http://books.google.com.pk/books?id=VhOnbTm4KEcC&pg=PA50&dq=bruner%27s+theory#PPP1,M1

Glaser, B. G., & Strauss, A. L. (1967). *The discovery of grounded theory: Strategies for qualitative research.* Chicago: Aldine.

Hameed, A. (2005). *Textbook social studies for class I.* Islamabad. National Book Foundation.

Harnqvist, K., & Burgen, A. S. V. (Eds). (1997). *Growing up with science: Developing early understanding of science.* Pennsylvania: Jessica Kingsley Publishers.

Hasan, B. (2005, May 12). Satellite moon sighting. *The News*, 12.

Hergenhahn. B. R., & Olson, H. M. (2005). *An introduction to theories of learning* (7th ed.). New Jersey: Pearson Prentice Hall.

Hill, E. K. (1957). Research concerning the nature of children's ideas in relation to scientific phenomena. *Science Education*, *41*(4), 261-268.

Hogan, K., & Maglienti, M. (2001). Comparing the epistemological underpinnings of students' and scientists' reasoning about conclusions. *Journal of Research in Science Teaching*, *38*(6), 663-687.

Homa, D., Rhoads, D., & Chambliss, D. (1979). The evolution of conceptual structure. *Journal of Experimental Psychology*: *Human Learning and Memory*, *5*, 11-23.

Horsburgh, N. (2002). *New Oxford primary science.* Oxford University Press. Karachi. Pakistan.

Howes, V. E. (1998). Connection girls and science: A feminist teacher research study of a high school prenatal testing unit. *Journal of Research in Science Teaching, 35*(8), 877-896.

Hussain, F., Qasim, M. A., & Sheikh, K. M. (2003). Analysis of public expenditure on education in Pakistan. *The Pakistan Development Review, 42* (4 Part II), 771-780. Retrieved February 21, 2009, from http://mpra.ub.uni-muenchen.de/2722/MPRA paper No. 2722, posted 07. November 2007.

Hussain, M. T. (2003). *A textbook of science for class I.* Islamabad: National Book Foundation.

Hussani, M. T., & Shaheen, D. (2004). *A textbook of science for class III.* Islamabad. National Book Foundation, Islamabad.

Independent Evaluation Group. (2007). *Case study: Pakistan executive summary.* Retrieved March 15, 2009, from http://www.worldbank.org/oed/education/pakistan.html

Iqbal, M. H. (1997). *A study on the effectiveness of intervention methodology on the cognitive development of science students.* Unpublished doctoral dissertation, University of the Punjab, Lahore, Pakistan.

Jalalpuri, I. M., Raja, J. I., Nawaz, P., Riaz, R., Rehman, S., & Muhammad, T. (2005). *Tesri darsi kitab: Hisa awal* [Primer of Urdu for Class III: Part first]. Islamabad. National Book Foundation.

Jalalpuri, I. M., Raja, J. I., Nawaz, P., Riaz, R., Rehman, S., & Muhammad, T. (2003). *Tesri darsi kitab: Hisa doam* [Primer of Urdu for Class III: Part second]. Islamabad. National Book Foundation.

Jalalpuri, I. M., Raja, J. I., Parveen, Mrs., & Muhammad, T. (2003). *Pehli darsi kitab* [Primer of Urdu for Class I]. Islamabad. National Book Foundation.

Kazemek, F., Louisell, R., & Wellik, J. (2007, June). *Children's stories about their natural worlds: An exploration from multiple perspectives.* Paper Presented at the Jean Piaget society Annual Meeting, Geneva, Switzerland.

Khan, E. S. (2006, January 21). Lunar talk. *The News*. p. 8.

Klausmeier, H. J., Ghatala, E. Es., & Frayer, D. A. (1974). *Conceptual learning and development: A cognitive view*. New York: Academic Press.

Kozulin, A. (1998). *Psychological tools: A sociocultural approach to education.* Cambridge. MA: Harvard University Press.

Kuethe, J. L. (1963). Science concepts: A study of "sophisticated" errors. *Science Education, 47*, 361-364.

Laura, L. S., Gerald, H. K., & Danial, P. S. (1999). Third grade students' ideas about the lunar phases. *Journal of Research in Science Teaching, 36*(2), 159-177.

Leal, J. D. (1993, December). *A comparison of third grade children's listening comprehension of scientific information using an information book and an informational storybook*. Paper presented at the National Reading Conference, Charleston, SC.

Lee, O. (1999). Science knowledge, world views, and information sources in social and cultural contexts: Making sense after a natural disaster. *American Educational Research Journal*, *36*(2), 187-219.

Lemke, L. J. (2001). Articulating communities: Sociocultural perspectives on science education. *Journal of Research in Science Teaching*, *38*(3), 296-316.

Leonard, G. B. (1970). *Education and ecstasy.* London: John Murray Ltd. England.

Levin, M. H., & Lockheed, E. M. (Eds.). (1993). *Effective schools in developing countries: The Stanford series on education and public policy*. NY: Falmer Press.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Beverly Hills, CA: Sage.

Matthews, M. R. (1992). *Science teaching: The role of history and philosophy of science*. New York: Routledge.

Medinick, A. S., Pollio R. H., & Loftus F. E. (1973). *Learning*. (2nd ed.). Englewood Cliffs. NJ: Prentice-Hall.

Memon, A. J. (2006). *Determination of social factors influencing girls primary education in rural area of Sindh: A research study*. Unpublished doctoral dissertation, Department of Education, University of Karachi, Pakistan.

Memon, R. G. (2007). Education in Pakistan: The key issues, problems, and the new challenges. *Journal of Management and Social Sciences, 3*(1), 47-55. Retrieved 15 June, 2009 from http://www.biztek.edu.pk/downloads/research/jmss_v3_n1/5%20EDUCATION%20IN%20PAKISTAN.pdf

Ministry of Education. (2009). *Expenditure/spending on education*. Retrieved March 15, 2009, from http://www.moe.gov.pk/faqs.htm?#q4

Monteiro, M. T. D. L., Batista, S. M., Mendes, S. M. P., Rodrigues, E. C. & Teixeira, E. (1993, July). *The child's view of the world: The origin of moon, sun and stars*. Paper presented at the Biennial Meeting of the International Society for the Study of Behavioral Development, Recife, Brazil.

Moore, R. G., & Moore, D. P. (1995). Constructing understanding of natural phenomena. *Science Activities*, *32*(1), 12-14.

Muhammad, F. R., & Kumari, R. (2007). Effective use of textbooks: A neglected aspect of education in Pakistan. *Journal of Education for International Development, 3*(1). Retrieved 10 June, 2009, from http://www.equip123.net/JEID/articles/5/EffectiveUseTextbooks.pdf

Muhammad, T. (2008). *Urdu ka nia qaida* [New Primer of Urdu for Class I]. Islamabad. National Book Foundation.

Mustafa, M. T. (2004). *Islamiat brai jamat awal* [Islamiat for Class I]. Islamabad: National Book Foundation.

Naughton, W., Schreck, J., & Heikkinen, H. (2008). Seeking evidence for "Curricular Relevancy" within undergraduate, liberal arts chemistry textbooks. *Journal of Research in Science Teaching, 45*(2), 174-196.

Nicholl, T. (1998). *Vygotsky*. Retrieved June 21, 2007, from http://www.massey.ac.nz/~alock/virtual/trishvyg.htm

Nisbett, R. (2003). *The geography of thought: How Asians and Westerners think differently...and why*. New York: The Free Press.

Novak., D. J., & Musonda., D. (1991). A twelve-year longitudinal study of science concept learning. *American Educational Research Journal*, *28*(1), 117-153.

O'Loughlin, M. (1992). Rethinking science education: Beyond Piagetian constructivism: Toward a sociocultural model of teaching and learning. *Journal of Research in Science teaching*, *29*, 791-820.

O'Neill, D. K. & Polman, J. L. (2004). Why educate "little scientists?" Examining the potential of practice-based scientific literacy. *Journal of Research in Science Teaching, 41*, 234-266.

Padgett, D. K. (1998). *Qualitative methods in social work research: Challenges and rewards.* Thousand Oaks, CA: Sage.

Paris, S. G., & Cross, D. R. (1998). The zone of proximal development: Virtues and pitfalls of a metaphorical representation of children learning. *The Genetic Epistemologist*, *16* (1), 27-37.

Patton, M. Q. (1980). *Qualitative evaluation methods.* Beverly Hills, CA: Sage.

Pervez, M. (1992). *Concrete operational thought as a construct and its relevance to school education in Pakistan*. Unpublished doctoral dissertation, National Institute of Psychology, Qauid-i-Azam University, Islamabad, Pakistan.

Peter, R., Margarita, G., & Tracy, M. (2000). Moon watch: A parental-involvement homework activity. *Science Activities*, *36*(4), 11-15.

Phillips, C. D. (1995). The good, the bad, and the ugly: The many faces of constructivism. *Educational Researcher*, *24*(7), 5-12.

Piaget, J. (1975). *The child's conception of the world.* Totowa, NJ: Littlefield, Adams, and Company.

Piaget, J. (2007). *The child's conception of the world.* Retrieved August 8, 2009, from http://books.google.com.pk/books?id=RWZIOL0NDLwC&printsec=frontcover&source=gbs_v2_summary_r&cad=0#v=onepage&q=&f=false

Piaget, J., & Valsiner, J. (2001). *The child's conception of physical causality*. Library of Congress. Retrieved August 7, 2009, from http://books.google.com.pk/books?id=_RUQHiX-5HoC&dq=Piaget%27s+Stage+of+Physical+Causality&printsec=frontcover&source=bl&ots=jdMTYDFGqt&sig=GQUQcEN3JowMa-VQ1tNBGZSmU4s&hl=en&ei=5r57SuyUG476kAWK0vDqAg&sa=X&oi=book_result&ct=result&resnum=2#v=onepage&q=&f=false

Povey, R., & Hill, R. (1975). Can pre-school children form concepts? *Educational Research, 17*(3), 180-192.

Rashid, A. (2003). *Learning mathematics for class I.* Islamabad. National Book Foundation.

Rashid, A. (2005). *Learning mathematics for class III.* Islamabad. National Book Foundation.

Ratto, K. (1971). The moon in literature. *Elementary English*, *48*(8), 932-936.

Reveles, M. J., Kelly, J. G., & Duran, P. R. (2007). A sociocultural perspective on mediated activity in third grade science. *Cultural Studies of Science Education.* Retrieved June 21, 2007, from http://www.springerlink.com/content/51323463v8305634/

Rider, S. (2002). Perceptions about moon phases. *Science Scope*, *26*(3), 48-51.

Robert, C. (1992). Using the moon as tool for discovery-oriented learning. *Journal of Geological Education, 40*(2), 142-46.

Rodriguez, J. A. (1998). Strategies for counterresistance: Toward sociotransormative constructivism and learning to teach science for diversity and for understanding. *Journal of Research in Science Teaching, 35*(6), 589-622.

Roemischer, D. M. (1969). A structural analysis of selected aspects of Jean Piaget's theory of cognitive development. *Educational Horizons, 47*(3), 127-136.

Saleem, M. (1991). *A strategy plan for universal primary enrollment in Pakistan by the year 2000*. Unpublished doctoral dissertation, Columbia University.

Saltmarsh, S. (2007). *Picturing economic childhoods: Agency, inevitability and social class in children's picture books.* Retrieved May 17, 2007, from http://ecl.sagepub.com

Samarapungavan, A., Vosniadou, S., & Brewer, F. W. (1996). Mental models of the earth, sun, and moon: Indian children's cosmologies. *Cognitive development, 11*, 491-521.

Scholnick , K. E. (1983). *New trends in conceptual representation: Challenges to Piaget's theory*. Hillsdale: Erlbaum.

Science Education in Pakistan. (n.d). *Innovative ways of bringing science to rural communities*. Retrieved 17 May, 2009, from http://web.mit.edu/ideas/www/past%20proposals/sepg.pdf

Scott, Asoko, Leach. (2007). Postcolonialism, indigenous students and science education. In K. S. Abell & G. N. Lederman (Eds.), *Handbook of research in science education* (pp. 31-56). Mahwah, NJ: Lawrence Erlbaum Associates.

Shami, P. A. (2006). *A textbook of science for class V.* Islamabad: National Book Foundation.

Sherman, R., & Webb, R. (Eds.). (1988). *Qualitative research in education: Forms and methods.* Lewes. UK: Falmer Press.

Smith, E. (1995). Where is the mind? Knowing and knowledge in Cobb's constructivist and sociocultural perspectives. *Educational Researcher*, *24*(6), 23-24.

Smith, F. (1964). A comparison of televiewing and non-televiewing children's explanations of natural phenomena. *Science Education, 48*(1), 90-93.

Smith, K, P., Cowie, H., & Blades, M. (2003). *Understanding children's development.* (4th ed.). Oxford: Blackwell.

Smith, S. W. (2003). Meeting moon global perspective. *Science Scope*, *26*(8), 24-28.

Solano-Flores, G., & Nelson-Barber, S. (2001). On the cultural validity of science assessments. *Journal of Research in Science Teaching, 38*(5), 553-573.

Southwest Educational Development Laboratory. (1995). Building an understanding of constructivism. *Classroom Compass*, *1*(3). Retrieved 15 June, 2009 from http://condor.admin.ccny.cuny.edu/~hhartman/Building%20an%20Understanding%20of%20Constructivism.htm

Stahly, H. L., Krockover, H. G., & Shepardson, P. D. (1999). Third grade students' ideas about the lunar phases. *Journal of Research in Science Teaching, 36*(2), 159-177.

Stake, R. (1995). *The art of case study research*. Thousand Oaks. CA: Sage.

Staver, J. R. (1998). Constructivism: Sound theory for explicating the practice of science and science teaching. *Journal of Research in Science Teaching*, *35*(5), 501-520.

Stead, B. F., & Osborne, R. J. (1980). Exploring science students' conceptions of light. *Australian Science Teachers Journal*, *26*(3), 84-90.

Strauss, A., & Corbin, J. (1990). *Basics of qualitative research: Grounded theory procedures and techniques.* Newbury Park, CA: Sage.

Sutton, C. R. (1980). The learner's prior knowledge: A critical review of techniques for probing its organization. *European Journal of Science Education*, *2*(2), 107-120.

Taylor, J. I. (1996). Illuminating lunar phases. *Science Teacher*, *63*(8), 39-41.

Tennyson, R. D., & Park, O. (1980). The teaching of concepts: A review of instructional design research literature. *Review of Educational Research*, *50,* 55-70.

Tennyson, R. D., Chao, J. N., & Youngers, J. (1981). Concept learning effectiveness using prototype and skill development presentation forms. *Journal of Psychology*, *73*(3), 326-334.

Tharp, R. G., & Gallimore, R. (1998). *Rousing minds to life: Teaching and learning in social context.* New York: Cambridge University Press.

Thompson, C. T., & Rudolph, L. B. (1992). *Counseling children*. (3rd ed.). Pacific Grove. CA: Brooks/Cole.

Thompson, W. K., & Harrell, E. M. (1997). Geometry and moon phases. *Science Scope, 21*(2), 35-37.

Trundle, C. K., & Troland, H. T. (2005). The moon in children's literature. *Science and Children*, *43*(2), 40-3.

Trundle, C. K., Atwood, K. R., & Chirstopher, E. J. (2006). Preservice elementary teachers' knowledge of observable moon phases and pattern of change in phases. *Journal of Science Teacher Education, 17*(2), 87-101. Retrieved June, 19, 2009, from http://www.springerlink.com/content/y748838q7p0q2320/

Trundle, C. K., Atwood, K. R., & Christopher, E. J. (2002). Preservice elementary teachers' conceptions of moon phases before and after instruction. *Journal of Research in Science Teaching*, *39*(7), 633-658.

Tytler, R., & Peterson, S. (2004). From "try it and see" to strategic exploration: Characterizing young children's scientific reasoning. *Journal of Research in Science Teaching, 41*(1), 94-118.

Ullah, R. S. (1972). *The impact of culture conflict on identity: With an emphasis on Pakistan.* Unpublished doctoral dissertation, University of the Punjab, Lahore, Pakistan.

Unicef. (2009). *Unite for children. Pakistan Statistics*. Retrieved March 15, 2009, from http://www.unicef.org/infobycountry/pakistan_pakistan_statistics.html#26

Vitz, C. P. (1985). *Religion and traditional values in public school textbooks: An empirical study*. (Report No. NCRTL-RR-92-4). NY: New York University.

Von Glasersfeld, E. (1989). Facts and self from a constructivist point of view. *Poetics, 18*(4-5), 435-448.

Vygotsky, L. S. (1962). *Thought and language*. Cambridge. MA: Institute of Technology Press.

Vygotsky, L. S. (1978). *Mind in society*. Cambridge. MA: Harvard University Press.

Watts, D. M., & Zylbersztajn, A. (1981). A survey of some ideas about force. *Physics Education, 16*, 360-365.

Wertsch, J. V. (1985). *Vygotsky and the social formation of mind*. Cambridge. MA: Harvard University Press.

Wertsch, J. V. (1991). *Voices of the mind: A sociocultural approach to mediated action*. Cambridge. MA: Harvard University Press.

Wilhelm, J. (2009). A case study of three children's original interpretations of the moon's changing appearance. *School Science and Mathematics, 109*(5), 247-290.

Windschtil, M., & Andre, T. (1998). Using computer simulations to enhance conceptual change: The roles of constructivist instruction and student epistemological beliefs. *Journal of Research in Science Teaching*, *35*(2), 145-160.

Witz, G. K. (2006). The participant as ally and essentialist portraiture. *Qualitative Inquiry*, *12*(2), 246-268. Retrieved March 21, 2007, from http://qix.sagepub.com/cgi/content/abstract/12/2/246

Witz, G. K., Goodwin, R. D., Hart, S. R., & Thomas, S. (2001). An essentialist methodology in education-related research using in-depth interviews. *Journal of Curriculum Studies, 33*(2), 195-227.

Annexure A

Levels of Contents

LC 0= No evidence of science concepts

LC 1=some indication in title or diagram, that this page can be related to science concepts at some level.

LC 2=Description of naturalistic phenomena, that can be related to science concepts at some level.

LC 3=Naturalistic phenomena with some scientific explanation in imaginative context.

LC 4= Material that contains a pure scientific explanation.

LC 5= Combination of the levels 2 and 3 (description and explanation of naturalistic phenomena in imaginative context).

LC 6= Combination of the levels 2, 3, and 4 (description, imaginative, and scientific explanation of science concepts).