ISSN 0019-4700 (Print)
ISSN 0972-561X (Online)

Indian Educational Review

Volume 58 **Number 1** **January 2020**

विद्यया ऽमृतमश्नुते
एन सी ई आर टी NCERT
राष्ट्रीय शैक्षिक अनुसंधान और प्रशिक्षण परिषद्
NATIONAL COUNCIL OF EDUCATIONAL RESEARCH AND TRAINING

ISSN 0019-4700 (Print)
ISSN 0972-561X (Online)

HALF-YEARLY JOURNAL OF EDUCATIONAL RESEARCH

INDIAN EDUCATIONAL REVIEW

Volume 58 Number 1 January 2020

CONTENTS

Summary of ERIC Projects

EDITORIAL

The current issue of *Indian Educational Review* carries one research review article on the theme of Science Education in India, five research papers, and summaries of two ERIC sponsored research projects. The Hindi versions of the abstracts of the research review and research papers have also been included.

The current issue carries review of researches on science education conducted in India from the year 2000 by R.R. Koireng. The review extensively covers studies concerning curriculum and teaching learning resources, cognitive studies, science teaching and learning, creativity, gender issues, achievement in science, and environmental concerns. An attempt has been made to identify the research gaps and suggest areas for future research in the domain of teaching-learning of science.

Five research papers have been included in this issue. The first paper, 'What Guides Inference Generation? A Study of Young Hindi Learners Studying in Challenging Contexts in India' by Lina Mukhopadhyay and her associates have examined the causes of individual differences in learning hindi as a mother tongue. Vinay Kumar Singh, in his paper, 'Profile Study of a School Going Child with Haemophilia', has reported the results of case study of a child suffering from haemophilia and has offered suggestions for preparing guidelines as well as training of teachers and parents for dealing with such children. In his paper, 'Construction and Validation of an Aptitude Test for Pre-service Teachers on Inclusive Education', H.S. Mistry has illustrated the development of a measure for assessing pre-service teachers' teaching aptitude towards education of children with disabilities. In the next paper, 'Ethno-mathematics: Mathematics Embedded in the Traditional Activities of the Kumhar Community of the Varanasi District'. Harish Pandey and Anjali Bajpai have attempted to locate the learning of some of the concepts of mathematics in the activities of Kumhar community of India. The last paper by Alka Seth and Novrattan Sharma titled, 'Life Skills: Predictors of Well-being among School Going Students' have examined the relationship between life skills and well being of students.

The summaries of two completed ERIC projects by Kirti Kapur, 'A Study of Language across the Curriculum Pedagogy on Students' Learning' and Loknath Mishra, 'Developing a Framework of Pedagogical Content Knowledge on Arithmetic for the Primary School Teachers of Mizoram' have been included in this issue.

The *Indian Educational Review* focuses on enriching the discipline of education by disseminating findings of educational research, providing opportunities for exchanging research

experience among fellow researchers, motivating academicians and providing inputs to all those involved in policy making and planning. Contributions of academicians, researchers, and freelancers are cordially invited for the next issue. We seek your suggestions and views on improvement of the journal and research initiatives.

Academic Editor

INDIAN EDUCATIONAL REVIEW

The *Indian Educational Review* is a bi-annual journal, brought out by the National Council of Educational Research and Training (NCERT), New Delhi. The journal publishes articles and researches on educational policies and practices and values material that is useful to practitioners in the contemporary times. The journal also provides a forum for teachers to share their experiences and concerns about schooling processes, curriculum, textbooks, teaching-learning and assessment practices.

The views expressed by individual authors are their own and do not necessarily reflect the policies of the NCERT, or the views of the editor.

OFFICES OF THE PUBLICATION DIVISION, NCERT

NCERT Campus
Sri Aurobindo Marg
New Delhi 110 016 Phone : 011-26562708

108, 100 Feet Road
Hosdakere Halli Extension
Banashankari III Stage
Bengaluru 560 085 Phone : 080-26725740

Navjivan Trust Building
P.O.Navjivan
Ahmedabad 380 014 Phone : 079-27541446

CWC Campus
Opp. Dhankal Bus Stop
Panihati
Kolkata 700 114 Phone : 033-25530454

CWC Complex
Maligaon
Guwahati 781 021 Phone : 0361-2674869

Single Copy : ₹ **50.00**
Annual Subsciption : ₹ **100.00**

Research Review Article

Research in Science Education in India

R.R. KOIRENG*

ABSTRACT

Realising the importance of improving the practice of teaching-learning of science in schools, science education has, in recent years, emerged as an independent field of research. The paper reviews science education research, conducted after 2000 related to the issues and concerns of teaching and learning of science in Indian schools. It includes research reports, research journals and articles. In order to provide good science education to children, it is important to understand the nature of science, the way contents are organised and presented, the pedagogy adopted, textbooks and other teaching-learning materials, the assessment and evaluation scheme adopted, and so on. All these require an in-depth research to unravel the best practices to be adopted. The present review of research in science education is broadly classified into seven areas, namely—curriculum and teaching-learning resources, cognitive studies, science teaching and learning, creativity, gender issues, achievement in science, and environmental concerns. The essence of researches in each area is given, including the trends and suggestions for further research. The understanding of various issues in science education through these researches will provide insights in improving the science curriculum, teaching-learning materials and pedagogical practices to be followed in teaching science.

सारांश

हाल के वर्षों में विद्यालयों में विज्ञान के शिक्षण-अधिगम के अभ्यास में सुधार के महत्व को समझते हुए विज्ञान शिक्षा अनुसंधान के एक स्वतंत्र क्षेत्र के रूप में उभरा है। यह शोध समीक्षा 2000 के बाद के वर्षों में भारतीय विद्यालयों में विज्ञान के शिक्षण और अधिगम संबंधित मुद्दों

* *Associate Professor*, Curriculum Group, NCERT, New Delhi-110016 (e-mail: karenkrr@gmail.com).

और सरोकारों पर किये गए विज्ञान शिक्षा अनुसंधान की समीक्षा करता है। इसमें शोध रिपोर्ट, शोध पत्रिका में प्रकाशित शोध पत्रों को सम्मिलित किया गया है। बच्चों को अच्छी विज्ञान शिक्षा प्रदान करने के लिए विज्ञान की प्रकृति, विषय-वस्तु को व्यवस्थित और प्रस्तुत करने के तरीकों, शिक्षण विधियों के उपयोग, पाठ्यपुस्तकें और अन्य शिक्षण-सामग्री, मूल्यांकन और मूल्य-निर्धारण योजना का ज्ञान आवश्यक है। वर्तमान समीक्षा में विज्ञान शिक्षा से संबंधित सात क्षेत्रों को शामिल किया गया है: पाठ्यचर्या और शिक्षण अधिगम संसाधन, संज्ञानात्मक अध्ययन, विज्ञान शिक्षण और अधिगम, सर्जनात्मकता, लिंग संबंधी मुद्दे, विज्ञान में उपलब्धि और पर्यावरण संबंधी सरोकार। प्रत्येक क्षेत्र में अनुसंधान का सार दिया गया है, जिसमें भविष्य में अनुसंधान के लिए सुझाव सम्मिलित हैं। यह समीक्षा विज्ञान शिक्षा में विभिन्न मुद्दों की समझ, विज्ञान के पाठ्यक्रम में सुधार, शिक्षण- सामग्री और विज्ञान शिक्षण में पालन किए जाने वाले शिक्षा-शास्त्रीय विधियों में सुधार पर बल देता है।

Introduction

Humans are by nature curious and inquisitive. This curiosity and inquisitiveness have driven them since time immemorial to explore the nature in different ways. One kind of response from the earliest times has been to observe the physical and biological environment carefully, look for any meaningful patterns and relationships, make and use new tools to interact with nature, and build conceptual models to understand the world. This human endeavour is called science. Broadly speaking, the scientific method involves several interconnected steps: observation, looking for regularities and patterns, making hypotheses, devising qualitative or mathematical models, deducing their consequences, verification or falsification of theories through observations and controlled experiments, and thus arriving at the principles, theories and laws governing the natural world. The laws of science are never viewed as fixed eternal truths. Even the most established and universal laws of science are always regarded as provisional, subject to modification in the light of new observations, experiments and analysis.

Science is a dynamic, expanding body of knowledge, covering ever-new domains of experience. In a progressive forward looking society, science can play a truly liberating role, helping people escape from the vicious cycle of poverty, ignorance and superstition (*NCF, 2005*).The advances in science and technology have transformed traditional fields of work such as agriculture and industry, and led to the emergence of wholly new fields for engagement. People today are living in a fast-changing world where the most important skills

are flexibility, innovation and creativity. These different imperatives have to be kept in mind in shaping science education.

Nature of Science Education

About six decades ago science education came to be recognised around the world as an independent field of research. The concerns of research in science education are distinct from the concerns of sciences and those of general education. Its methods and techniques were initially borrowed from the sciences but now new methods are being developed which are well suited to the research questions. Motivation for this research comes from the need to improve the practice of teaching science. We begin by asking which methods of teaching work better than others? Studies in the 1970s typically compared experimental classrooms with control groups. New teaching aids were tried out; lecture method was compared with activity-based teaching, and so on. These studies gave useful results in particular contexts but it was hard to replicate them. Conditions in classrooms are varied; teachers and students in the classrooms too vary widely. Teaching and learning is a complex, context-dependent process and one needs to first describe this complexity in order to understand it, before eventually aiming to control it (Berliner, 2002). The aim of teaching science includes not only to acquire scientific facts and phenomenon involved but also to imbibe scientific temper and certain scientific values such as honesty, scientific attitude, integrity, cooperation, concern for life, preservation of environment, and so forth. Activities and experiments are the hallmark of science and they are also essential for science learning. The Hoshangabad Science Teaching Programme (HSTP) of 1970s, an initiative of the state of Madhya Pradesh, is an example of intervention in science teaching at micro level. The District Primary Education Programme (DPEP), the *Sarva Shiksha Abhiyan* (SSA) and the *Rashtriya Madhyamik Shiksha Abhiyan* (RMSA) also form a part of science teaching intervention at the macro level in schools of the country. These interventions had a varying impact on science education in the country.

Understanding the dynamics and diversity of classroom in the country gives us an insight into how science ought to be taught. Good science education requires not only a good teaching learning material, but also innovations to create interest in the learners. However, to begin with good learning materials will help the teachers and students in enabling them to learn science. Eventually, it is the

teachers who negotiate the teaching-learning process in the actual classroom. The ability of students to learn meaningfully the intended skills, values and attitudes depends upon the teaching strategies adopted by the teacher. Teacher is a very important component of science education that has deep influence on student's learning of the subject. Often misconceptions of the teachers are inadvertently transferred to the students. Though efforts are being made to teach science following the method of enquiry and hands on experience, it is of common sight in most of the schools that science teaching continues to be dominated by chalk and talk method. Sometimes it tends to be driven by examination system prevailing in the country and, in fact, more often than not teaching is influenced by the typology of the questions asked in the examination. This is more in Classes X and XII because of the board examinations in which the students have to appear.

To meaningfully teach science to children, it is imperative to know the nature of science, the way contents are organised, the teaching strategies adopted, resources and other teaching-learning materials required, the evaluation scheme adopted, and so on. All these requires an in-depth research to unravel the best practices to be adopted. Interest in science develops quite early in life (Gardner, 1975). The decline in interest in science in later years of studentship can be addressed to a certain extent by providing all the factors conducive to the development in science from early years itself.

Against this backdrop, this chapter reviews science education research, conducted during 2000–2015, related to the issues and concerns of teaching and learning of science in Indian schools. While doing so, attempts have been made to identify gaps in research in the field of science education that need urgent attention.

Past Surveys of the Research

The earlier reviews of research in education carried a chapter on science education in the fourth (Ganguli and Vashishtha, 1991), fifth (Vaidya, 1997), and sixth (Chunawala, 2006) surveys. The fourth survey of research in education covered researches conducted during 1983–1988, fifth survey during 1989–1992, and sixth survey during 1993–2000. The number of researches reported in fourth, fifth, and sixth surveys were 56, 61 and 120, respectively. The sources covered in the sixth survey were primarily *Indian Educational Abstracts, International Journal of Science*

Education, Journal of Research in Science Teaching and Journal of Education and Social Change. The researches were related to the following areas— Cognitive studies, science teaching, teaching materials, attitude and science, gender issues in science education, creativity, achievement in science, and environmental factors. The sixth survey highlighted the need to do more research in the field of history of science, philosophy of science and sociology of science, which are deeply intertwined, and also in science curriculum that would present not only science but also its very methodology as evolving with time. There is a need to develop curricula and teaching materials with these perspectives in mind.

The Present Survey

The present survey attempts to consolidate science education research conducted at the school level in the Indian context after 2000. Based upon the availability of researches, the chapter is divided into the following sub-sections— Curriculum and Curricular Materials, Cognitive Studies, Science Teaching and Learning, Creativity, Gender Issues, Achievement in Science, Environmental Concerns, and The Way Forward.

Curriculum and Curricular Materials

Curriculum is one of the most important areas of science education as it guides the entire process of teaching-learning. The science curriculum at the school level in India has undergone several changes in the past few decades both in terms of content and approach. Studies have been conducted to examine science curriculum, syllabus and teaching-learning resources including textbooks. This section examines studies pertaining to curriculum, teaching-learning materials including textbooks and teaching aids.

Curriculum

Scholars have conducted studies related to different aspects of science curriculum including the objectives and philosophy of science curriculum development. Ediger (2000) examined various parameters including organisation of science curriculum, assessing student achievement, philosophy/psychology of education for evaluating and designing science curriculum. The researcher (Ediger, 2013a) further examined philosophies of education which might provide guidance in developing science curriculum. Kulkarni (2013) studied a number of concerns related to curriculum development in science and mathematics, in terms of the explicitly

declared national goals and objectives such as providing equality of educational opportunity, improving rural schools, values in education, introduction of vocational stream, utilising field-tested methodologies, etc. These have implications for school curriculum, school infrastructure, teaching materials and teaching strategies. Awasthi (2000) highlighted the present educational scenario of the country and discussed the issue of relevance in great details. He proposed a number of suggestions for the development of school curriculum based on practices followed the world over and keeping in view the needs of the Indian society, its rich cultural heritage and inherent unity in diversity. The need for incorporation of value education in science teaching (Kishore, 2000) and restructuring of science instruction in the light of understanding gained in the nature of science (Sood & Saraswat, 2011) has also been reported.

Science education is dependent on context. This section contains studies concerning students' knowledge about selection and organisation of content in the Indian context. The study by Mehrotra and Banimal (2006), conducted in primary schools run by the Delhi government, reported that children coming from an agricultural background carry with them rich procedural knowledge about animals and plants, raised and grown in the farms. They suggested that while framing a curriculum for biology instruction, the cultural perspectives may be kept in mind. Another study (Gafoor and Narayan, 2010) conducted on upper primary students of Kozhikode district in Kerala found that out of school science experiences contributed to interest in science. It was further observed that the influence of experience on interest was more in biology than in physics and chemistry. The study advocated the need to take cognizance of these facts while preparing curriculum, teaching-learning materials and teaching strategies. Similar results for secondary students of Kozhikode district have also been reported (Gafoor and Jaithra, 2012).

Singh (2013) identified three important features of physics curriculum for rural teachers in terms of content, method and values of physics that constitute the scientific temper. Jain (2000) examined biology curriculum and found the need to incorporate developments in biotechnology and medicine, as well as concerns for the environment and survival of life. Similar concerns for incorporating disaster management (Kaur, 2010), nanoscience (Ravichandran and Sasikala, 2010), and agriculture (Sacheti and Mehrotra, 2000) in school curriculum have been expressed.

Thus, there is a growing concern to frame science curriculum taking into consideration the needs of the society, the experiences and context of the learners, etc. There is also a strong view among researchers to include new and emerging areas of science such as biotechnology, nanoscience, disaster management, agriculture, etc., in the science curriculum.

Curricular Materials

Research shows that though textbook is only one of the diverse teaching-learning materials for curriculum transaction, for the majority of school going students and their teachers, it is the only accessible and affordable curriculum resource. For example, Agarkar and Deshmukh (2002) studied the opinion of a large number of teachers teaching at the upper primary stage in Ashram schools, and found that textbook is the most important instructional material used in school teaching. They also reported that the content and style of textbook influenced learning of the subject and recommended that textbook should be modified suitably to facilitate learning of science among Ashram school students. Gangoli (2000) examined the important role of textbooks in curriculum transaction and found that the content of the text, its structure, method of presentation and the role of the teacher, etc., influenced the usefulness of the book and suggested an open-ended approach of developing textual materials. Parida and Goswami (2000) examined NCERT Class IX science textbook regarding analogies included in it and noted that at some places students are likely to develop misconceptions due to inadequate analogical explanation (AE).

Bansal (2014) examined the middle class science textbooks of NCERT and Eklavya for the ways in which they support scientific enquiry. The finding suggested that contextualising science by means of inquiry based textbooks would strengthen the bonds between science, society and develop critical inquiring minds. Das (2012) studied the effectiveness of self study materials for teaching general science vis-a-vis the traditional method adopted for teaching general science to Class IX students. The performance of the students taught through the developed self study materials was significantly higher than those taught through the traditional method. Hence, there is a consensus among researchers that textbook influences the method of teaching adopted by the teachers. The reviews also indicate the need for contextualisation of science content as per the context of students.

The findings of the research studies show that the basic facilities for teaching science such as laboratory, laboratory items and equipments are still lacking in schools. There is also concern regarding the utilisation of laboratory equipments among teachers in teaching-learning process. For example, Singh (2006) conducted an assessment of the existing facilities available in the high schools of Chimtuipui district of Mizoram. A total of 60 teachers (51 males and 6 females) from 40 different high schools of the district were included in the study. The findings revealed— (a) lack of qualified teachers in all types of school (b) lack of library, laboratory, equipment and chemicals, audio visual, acids, etc., and teachers were mainly using the translation method in the teaching of science. Another study (Sharma and Patel, 2006), conducted in 30 government SC or ST schools in Madhya Pradesh and 30 Jawahar Navodaya Vidyalayas (JNVs), reported the non availability of science laboratory at secondary level in SC or ST schools as compared to JNVs schools. The usage and effectiveness of science laboratory was found average in JNVs and below average in SC or ST schools. In another study (Ajitha and Pushpam, 2000), it was found that though most of the teachers agreed on the importance of teaching aids, yet few used it during teaching-learning process. Mohanty (2012), in a study conducted on biological science curriculum in Odisha secondary schools, reported many shortfalls like absence of laboratory in almost all the schools, textbooks with deficiencies, lack of appropriate and adequate teaching aids, non performance of co-scholastic activities, absence of access to community resources, lack of initiative to visit places of biological and scientific importance in order to connect knowledge to life outside the school and to make learning more practical rather than textbook centric.

Cognitive Studies

Cognitive studies in science refer to the studies concerned with learning of science. Cognitive research aims at developing a 'science of science learning'. Research studies in this category include understanding of science, misconceptions or alternative conceptions in science and cognition. This (cognitive studies) is a major area for research in science education. Researchers have examined the level of understanding of science and misconceptions or alternative conceptions held by the students and teachers.

Understanding of the Science

Difficulties in understanding science concepts, as well as organisation of content vis-a-vis cognitive level of the child have been examined. Haydock (2011) reported that a lot of problems were faced by teachers like work overload, too many duties, inadequate pay, etc. Other than these problems, science teachers complained about syllabus being difficult and vast, textbooks having mistakes, students not interested and science concepts not related to the students' lives. The study suggested about the lack of understanding concerning nature of science due to which science is actually not taught to students. Kala and Ramadas (2001) examined Piaget theory and reported that the Piaget's influence led to a shift from behaviourism to constructivism. They observed that developments in cognitive science too contributed to the research paradigms and methods, and the philosophy of perception and representation might guide research while work in the tradition of situated cognition might hold promise for a philosophy of praxis and action. Pant (2006) observed that the traditional definition of science as a systematically organised body of knowledge has been expanded to incorporate the processes and procedures of science. The processes of science emphasise science as a way of observing, thinking, creativity, investigating accurately and truthfully rather than adopting conformist orientation. The study (Pant, 2006) recommended proper sampling and representation of the contents in the textbooks and the relevance of the analysis of textbooks for enhancing the quality of science textbooks.

The metacognitive knowledge of strategy, task and personal variables enable students to perform better and learn more (Rajkumar, 2010). Padhi (2013) examined the relationship between cognitive preference style (CPS) and academic self concept in science (ASCSc) among secondary school students (200 students—102 boys and 98 girls from Class IX in four schools of Bhopal). Cognitive preference style of both high and low ASCSc groups of students was found to be same. Use of application was associated positively with ASCSc. Memory was negatively and significantly correlated with ASCSc and the relationship of questioning with ASCSc was found to be low.

Gupta (2000) in the paper titled, 'A Constructivist Enquiry Learning Model for Science Education' reported that psychological and social constructivist perspectives are supported by neurocognitive evidences where learning is both biologically and

socially mediated. Three sources of knowledge, i.e, spontaneous, formal and creative are integrated through self exploratory, collaborative, novel and technologically embedded experiences for developing multiple intellectual abilities like cognitive, creative and affective. The role of the teacher is envisaged both as an instructor and a facilitator matching the pedagogies with how students learn as opposed to purely didactic or absolutely getting out of the way of the students. Another study (Pal, 2000) found that the idea children hold through daily experiences about various concepts bring with them into classroom, which shapes the construction of the scientific knowledge in a particular way and this affects the methodology of science. Prabha (2010) reported various approaches to teaching-learning process in order to make students inquisitive thinkers, who question, reflect, reason, make association with prior learning, imagine and think.

Saminathan and Mohan (2002), based on their study on 10 low scoring students in physics in quarterly examination in government higher secondary school, Ariyankudi, reported the need for student counselling which can sensitise the individuals to their potential to determine what they would like to be. It helps the pupils to understand and classify their views of life space, and to learn to reach their self-determined goals through meaningful, well-informed choices and through resolution of problems of an emotional or interpersonal nature. They further reported that various cognitive factors like intelligence, creativity and memory, and other social factors like age, sex, social background also influence the students learning at different stages. The research thus shows that understanding the nature of science, process and procedure of science and the daily life experiences influence learning of science.

Misconceptions or Alternative Conceptions

Studies have examined misconceptions or alternative conceptions held by the students and teachers in different subject areas. Singh (2000) identified errors or misconceptions in physics at senior secondary level, such as electric line of forces, electric field, microscope and telescope, eye lens and objective lens, etc. It was reported that the causes of large number of failures or misconceptions were wide ranging beginning from poor teaching to unreliable evaluation procedures. He further mentioned that the need of the hour was to strengthen teaching in schools and

develop an evaluation system which is flexible, reliable and student-friendly. In a study conducted on a stratified sample of 627 pupils studying in Class IX in a district of Kerala, Gafoor and Akhilesh (2008) found that 42 per cent of high school students had misconception regarding majority of concepts in physics. About three-fourth of the sample exhibited misconceptions with the concepts of density, sound, work and gravity. Gender and rural-urban differences were reported. The study also suggested steps to remove the misconceptions. In another study (Sindhu and Sharma, 2000) conducted on 68 senior secondary students in Bhopal, it was found that students committed errors in naming coordination compound and in some other cases students developed misconceptions about the rules for naming coordination compound. Arora, Mahapatra and Parida (2010) identified episodic conceptualisation in the minds of pupils in the domain of interaction of the concepts 'kinetic energy and work'. Teaching strategies were suggested to reduce episodic conceptualisation such as emphasising on the interchangeability of 'kinetic energy and work' concept and designing activities to demonstrate the interchangeability of 'kinetic energy and work'.

According to Kishore (2002), lecturing and rote-learning lead to misconceptions in Physics. Parida, Mahapatra and Goswami (2000) examined secondary level learners' ideas about the inter-relationships between various concepts related to gravitation as well as their misconceptions. On the basis of their study on a sample of 93 students of Class IX and 166 students of Class X from two CBSE affiliated schools in Bhubaneswar, the researchers identified a number of misconceptions held by students related to gravitation, such as, 'Earth pulls objects towards its centre, moon does not pull objects towards its centre' and 'the gravitational force is constant throughout the universe'. The findings have implications on teacher, curriculum framers and textbook writers. Gupta and Ravichandran (2001) reported the performance and types of mistakes Class XI students commit in various concepts in Chemistry based upon knowledge, understanding and application of concepts. Sharma (2007) listed a number of common misconceptions concerning the topic of force among students across different levels. Some of the misconception reported about force were—(a) force continues to be associated with the body till it remains in motion (b) velocity and acceleration are inseparable physical quantities and are in the same direction (c) force is in the direction of velocity, etc.

A few studies have been carried out concerning teachers' misconceptions. Jain (2011) studied the misconception held by experienced teachers regarding simple harmonic motion (SHM) and reported several misconceptions held by the teachers pertaining to sign for displacement, velocity, and acceleration, its effect on speed during different time intervals and direction of acceleration. The strategies for transacting this concept were also reported. Similar study by Goswami and Parida (2004) revealed misconceptions held by PGT physics teachers on simple harmonic motion topic. Pachaury (2000) reported the anomalous performance of teachers on logical/spatial and coordination of perspective tasks. The study was conducted on 29 Biology/ Chemistry post-graduate teachers from 10 States and UTs. These teachers were in the age group of 27 to 35 years and had teaching experience of 2 to 7 years. Another study (Saxena, 2001) examined the existence of large number of misconceptions among the teachers related to physics teaching at senior secondary level in different parts of India. Sharma and Sharma (2003) reported an overwhelming number of teachers carrying many misconceptions about basic concepts of physical optics despite the fact that teachers were well qualified and had teaching experience of many years. The study was conducted on a group of 21 Physics PGTs of senior secondary school of repute having an average teaching experience of about 12 years.

Jadhao (2002) highlighted some of the common misconceptions prevailing amongst students as well as teachers concerning some basic concepts of light in the paper, 'Teaching of light up to secondary level'. Some relevant contents for teachers were provided to tackle this. Agarwal (2012) reported that lack of adequate thinking and visualisation leads to misconceptions or alternative conceptions not only in the minds of the students but also in the minds of the teachers. Some important aspects of motion in two and three dimensions vis–a–vis one dimension have been discussed to improve thinking and visualisation. Sharma and Singhai (2000) found a cognitive conflict in the minds of children in 12–14 years age group in physics. It was also found that the practicing teachers have very little knowledge or right kind of knowledge to solve such cognitive conflict in the mind of their student. The study adopted questionnaires and interview technique for collecting data among students in the age group of 12–14 years, practising teachers, prospective teachers, teacher educators and college teachers.

The review reveals that students and teachers have misconceptions related to many concepts of science. It also identified the poor teaching, rote learning and faulty evaluation practices followed as the main reason for misconception in students. Suggestions for improving misconceptions held in various concepts of science are also suggested, such as improving teaching-learning process, adopting flexible student-friendly evaluation procedure. These researches have varying implications on improving teaching practices, textbooks, evaluation procedure and teacher development programmes.

Science Teaching and Learning

Teaching and learning are complex processes and context dependent (*Teaching of Science position paper*, *NCF 2005*). Any science curriculum becomes meaningful and fruitful only when students are able to apply at least some of the science concepts in their daily life, otherwise their knowledge of science remains bookish, sterile and irrelevant in their lives. The transaction methods and strategies employed, contextualisation and innovative learning aids used for inculcating scientific temper, attitude and learning science concepts are examined in this section.

Scientific Temper

An important area of research on science teaching is inculcation of scientific temper and scientific attitude. Scientific temper is an attitude to different questions that arise in normal life of a human being (Panchapakesan, 2006). Lakshminarayan and Sreekala (2001) examined the correlation between science ability and science understanding in students. They found that science application ability was related to science process skill. Persons having advanced process skills showed higher ability to apply science in day to day life. The study was conducted in Koyilandy taluk of Calicut district in Kerala in which a total of 180 students of Class VII were randomly selected from six schools, using cluster random sampling method. Another study (Pant and Maitra, 2002) observed that talented students in science possessed positive attitude towards science. The study included 205 students of Classes IX and XI of two reputed public school in Delhi. Kartikeyan and Mohideen (2005) also reported that a positive correlation exist between the availability and utilisation of physics laboratory facilities and students attitude towards physics practical which

leads to attainment of scientific attitude. Ahamad, Raheem and Hasan (2003) in a study of 'Attitude of Secondary Students towards Science in relation to sex, socio-economic status and intelligence' did not find any difference in attitude towards science between male and female students. The students belonging to high socio-economic status showed more positive attitude towards science than their middle and low counterparts, and the students possessing high and middle levels of intelligence showed significantly greater attitude towards science. Moreover, the students of middle level intelligence showed relatively better attitude towards science than their low counerparts. Ahmad (2008) examined the role of a teacher in inculcating scientific temper amongst students. It was found that the responsibility of developing scientific temper among the students lies on teachers who can provide a variety of situations to instil in students the characteristic features of scientific attitude and at the same time present themselves as an example to the students. Pachaury (2006), in a study conducted on intellectual and procedural honesty on student-teachers in the practicals conducted by them, found a very low index of intellectual and procedural honesty. The study was conducted on 30 graduate and post graduate science student teachers studying in a B.Ed. college in Bhopal.

Sengupta and Chakraborty (2005) reported that a significant number of students at the upper primary and secondary grades, and even the trainees in different teacher education institutions, who aspire to be science teachers in near future, fail to show the evidence of scientific reasoning. The study was conducted on a sample of 794 students from Classes VII to X from different schools and 150 pre-service trainee science teachers from different teacher education institutes in Kolkata suburbs. Lakshminarayan and Lalitha (2002) examined the correlation between the attitude of students toward laboratory work and their performance in theory and practical. It was found that the attitude of students towards laboratory work does not influence their performance in theory and practical. It also concluded that the achievement of students in theory is independent of their attitudes towards laboratory work. Male and female students do not differ in their attitude towards laboratory work and there was no difference in their achievement in both theory and practical. The sample consisted of 120 students from CBSE, State government and private management schools of 10+2 students. Kumar (2013), in a review of empirical studies,

reported a positive relationship between science classroom variables and student attitude towards science, however the results were not conclusive.

The results of the studies, discussed above, shows that the ability to apply scientific applications is closely related to the science process skill. However, no conclusive relationship can be drawn between scientific temper and scientific attitude and more studies are required in this area.

Teaching Strategies

A number of teaching strategies for transacting curriculum have been studied. These include concept mapping method, inquiry method, problem solving approach, open-ended approach, project based method, etc. The studies clearly show the positive effects of alternative teaching methods in learning of science.

Dwivedi (2014) examined the effectiveness of inquiry training model in teaching science at secondary level. Four chapters of physics of Class IX were taught to 50 students through inquiry training model method and 50 students through conventional method. It was found that gain and retention of students receiving instruction through inquiry training model method was relatively higher than that students receiving instruction through conventional method. Kharatmal (2009) reported a significant increase in student understanding in the depiction of concepts and propositions using the concept mapping method as compared to the descriptive method. Positive impact of concept mapping strategy for improving the achievement of students of Class XII in organic chemistry has been reported (Sharma (2014). Sharma's study was conducted on 80 science students of Central Hindu Boys School, Varanasi, where pre-test, post-test non equivalent group design was used. Shailja (2009) also found concept mapping as an effective strategy to enhance student learning.

Basu and Thangasamy (2005) examined the effectiveness of small-group discussion with framing questions on comprehension of concepts in Physics at higher secondary level. The study was conducted on 60 students of Class XI. The results showed that the experimental groups taught with small group discussion with framing questions method showed improvement in comprehension of concepts in physics compared to their counterparts taught by small group discussion and traditional teaching methods. Kalia (2005) reported effectiveness of mastery learning strategy

over inquiry model on the achievement of students in science at Class VII level. In another study (Smitha and Rao, 2009) it was found that teaching through discovery learning facilitated inculcation of critical thinking among secondary school students as compared to traditional method. Sridevi's (2013) study showed that constructivist teaching is more effective than conventional teaching in terms of perception of nature of science among Class VIII students. Kishore and Tamhane (2013) reported children learned the effects of force better when hands-on activities related to daily life situations were given in comparison to the activities given in textbooks. Sharma (2002) found that students developed an appreciable mastery in practical skills of following instructions for doing practical work, reporting and drawing conclusions when proper instructions were given to students. The study was conducted on a sample of 33 students (20 boys and 13 girls) of Class X.

The effect of some innovative methods on science teaching has been examined. These included mobile science laboratory in schools (Avatar, 2000), constructivist method (Bala and Tandon, 2009), and non-directive teaching (Chanda and Mitra, 2000) for school students. Jain (2002) reported strategies for problem solving and creative thinking in science education. Jogi (2011) found that involving underprivileged students in participatory video activity fostered learning in science. Mody (2011) reported constructivist method for teaching physics concepts using problems where multiple intelligence can be developed among students and a dynamic assessment can be done while they learn. Mody and Pradhan (2011, 2014) have suggested a series of innovative ways on problem based learning in basic physics. Aggarwal (2003) suggested that open ended learning in chemistry was a learner friendly mode. Gupta (2010) reported that science is learnt best when it goes beyond the four walls of the classroom and addresses the concerns and problems of the larger community because then the science becomes alive and vibrant. Teacher should act as a teaching aid herself as well as she has to provide good environment and freedom of thought so that the children can pose novel ideas for learning science without using the boredom of books. Mehra and Mondal (2005) reported better learning outcomes in terms of achievement in science using peer tutoring than traditional instructional teaching.

Mohanty and Panda (2009) analysed learners' engagement in secondary school bioscience activity on a sample of 143 students

of secondary school in Odisha. They reported that 73 per cent of the sampled students developed interest to know more about bioscience. They liked to complete home task, write essays, articles, small poems, stories and preparing reports in the process of learning bioscience. They also reported that students' participation in seminar, debate, group discussion, etc., was unsatisfactory and attributed it to the lack of opportunities. Pareek, Vidyapati and Arya (2012) studied the impact of micro scale laboratory kits on students' achievement in chemistry practical and found that working with micro-scale chemistry kit for one academic year helped students to improve their chemistry practical skills but did not help in improving their cognitive skills. Gangoli and Gurumurthy (2013) examined the effectiveness of open-ended approach for conducting physics experiment. They found that guided open-ended approach is better than the traditional laboratory approach in the promotion of cognitive abilities like knowledge and understanding whereas it does not have marked difference in developing creativity.

Innovative Methods

Researchers have developed innovative methods of teaching different science concepts. Included among them are—analysis of environment pollutants such as sulphur dioxide, nitrogen oxides (Sindhu and Sharma, 2002), evaluation of Planck's constant using torch bulb and light emitting diode (Dash and Mahapatra, 2007), verification of Boyle's Law (Bapat and Rao, 2002), inexpensive atomic and molecular models (Gupta, 2000b), learning science concepts with discarded materials such as soda straw, plastic bottles and polythene bags (Kishore, 2003, 2006), integrating critical thinking skills in classroom (Shaffi and Ravichandran, 2002), mole concept (Mehrotra and Koul, 2012), measuring focal length of a lens using low power laser (Ratna, 2001), etc. Story telling as a constructivist tool in science teaching was examined by Tandon (2011) and found improvement in the performance of learners. Maitra (2009) applied the projective motion of cricket ball to explain science concept in the game of cricket. A number of innovative problem solving activities for senior secondary biology students were examined (Shaffi, 2000). Lambhate and Choudhari (2013) developed an innovative way of teaching science using Bullock-cart. Parkash (2000) reported innovative way of assessing toxicity of nitrates and nitrites. Praveen (2012) reported effectiveness of tree-chart for teaching botany at higher secondary level. Seetharamappa (2012)

reported innovative way of learning periodic table through games. Gupta (2000a) reported simple procedure for demonstration of the pressure effect in NO_2–NO_2 equilibrium state. Likewise, Shukla, (2000) reported an innovative method of linking electrode potential for predicting the products of the reaction in chemistry. Mali (2001) reported the detailed analysis of the buoyant force and its connection to fluid pressure. Sengupta (2001) discussed innovative methods of concept learning in science and reported that the meaning of a scientific concept is scientifically valid only if what scientists intended by it becomes actual, i.e., problems are solved and intentions are fulfilled as enquiry continues.

Teaching-learning is a complex process, however some effective teaching strategies are reported in this review such as concept mapping approach, open-ended approach, problem solving approach, conducting hands on activities related to daily life, etc. A number of innovative methods for teaching specific concepts are also reported; however, this requires further testing before implementing at the mass level. These innovative strategies or methods are pointers which can be adopted for bringing improvement in teaching-learning process.

Creativity

Creativity research in the early years focussed on conceptualisation, identification and assessment of creative talents. However, as Grewal (2000) reported, the research conducted during the past four decades has shown that creativity can be fostered and has advocated for adopting curricular approaches for training of creativity. Gupta (2000) opined that the concept of creativity is a multifaceted phenomenon and offered some suggestions on how creativity can be nurtured through chemistry curriculum.

Visual representation or visualisation is main focus in a number of studies for inculcating innovation and creativity. The articles, by Ramadas (2013) on 'Visual Representation of Water Cycle in Science Textbooks', Kala and Ramadas (2009) on 'Visual and Spatial Modes in Science Learning' and Mathai and Ramadas (2009) on 'Visuals and Visualisation of Human Body Systems', all reported the role of visualisation in creativity, in building mental models and in the communication of scientific ideas. Prior knowledge strongly influences the visualisation and comprehension of texts and diagrams including the ability to move flexibly

between texts and diagrams. These visuals and texts also need to be appropriately integrated within the textbook. Aggarwal (2000) found that creativity is a developmental process which flourishes best in a free and relaxed atmosphere in a truly democratic set up. It also suggested that divergent thinking, which results in creativity, can be promoted through open education. Dogra (2010) observed that a creative teacher can identify the talent in a child or they can make the boring topic more interesting by performing some simple classroom or school activities which encourages thinking, understanding, exploration, problem solving, collaboration, problem solving, collaboration, analysis and prediction for learning of different subjects. The studies thus show that creativity can be nurtured in children by providing stimulating environment to think and explore, and by encouraging divergent thinking and visualisation. This, of course, has implications for developing teaching-learning materials and adopting suitable teaching strategies.

Gender Concerns in Science

Gender issues have emerged as one of the most important topic in the perspective of science education in the Indian context. Throughout the history, women had limited access to education and technology. The participation of women in science and technology even today is relatively on the lower side. Any technology is the product of social relations and forces and choices are shaped by the social arrangements. As discussed by Sugra Chunawala in the chapter, 'Education and Technology Education within the Gender Perspective' (2004) in the book '*Books for Change*', the education system plays an important role in the formation of gender identity. Today, science and technology are viewed as masculine disciplines. However, the major concern is less interest shown by women and girls toward science as compared to men. It is established that cognitive ability is not the reason for difference between the interest of boys and girls in science. Kishore (2004) observed that popular media projection of scientists as eccentric seems to be keeping girls away from physics courses. He further mentioned that if lesser number of girls are attracted to science courses, then it is the matter of attitude and the queer image of science teaching as being remote, difficult and masculine.

Raveendran and Chunawala (2015), employing a feminist critique approach, examined how values get communicated in

biology curriculum. They reported that while the reproductive approaches focus more on the pedagogy of science and attempt to incorporate learning styles and examples that are closer to the lived experiences of girls and ethnic minorities, they essentially reproduce the knowledge structure without questioning it. Resistant approaches, on the other hand, go a step further to question the fact-value dichotomy that is rigidly maintained in the science curriculum and seeks to relocate science in a socio-political context. The authors (Raveendran and Chunawala, 2015) suggest that textbook writers and teachers need to reflect and make explicit the value-frameworks that underpin the 'facts' communicated to the students.

The results of the studies examining gender differences in science are not conclusive. For example, in a longitudinal study, Gafoor (2013) found that interest in physics has declined more among girls than boys. Even in general, the decline of interest of girls is more in physics than interest in science, while decline of interest of boys is less in physics than interest in science. Vidyapati and Prakasa Rao (2003) reported a significant gender difference in favour of girls in science achievement. However, no significant gender difference in scientific attitude and scientific creative abilities was observed. In another study, Sharma (2002) examined science practical skills of students at secondary level. The practical task was drawn from secondary curriculum and was administered to 33 students (20 boys and 13 girls) of Class X to assess their performance in the skills of following instruction, reporting and drawing conclusion. The results reported an appreciable difference between the performance of boys and girls. Agarwal and Gupta (2010) on a study conducted to assess the problem solving ability in physics among intermediate level students in relation to their sex, locality and types of school. The findings indicate that sex and type of school both influenced physics problem-solving ability of the students. Students of privately managed schools and girl students have better physics problem solving ability than their respective counterparts.

More discerning efforts are, obviously, needed to remove gender bias from textbooks and classroom practices. Gender sensitisation of teachers both at the pre-service stage and during in-service training is necessary to promote gender-fair science education. The curriculum should also strive to make the contribution of women to the field of science and technology 'visible'. Teachers should

be sensitised to promote equitable classroom practices to ensure 'science experiences' of comparable quality to girls.

Achievement in Science

Over the years, a lot of emphasis is given to monitor and increase the achievement of students. However, the achievements of students continue to be a major area of concerns for government, researchers and educationist. The reports of the National Achievement Survey (NAS-2017) for elementary students and the National Achievement Survey (NAS-2018, Cycle 2) for Class X students present a grim reality regarding the achievement of students in the country. As per the reports, the national average score in science for Class VIII students is 44 per cent and for Class X students is 34 per cent only. Assessment and evaluation form an inseparable part of the teaching-learning process. However, the examination system in place today in the country continues to dominate the teaching-learning process. This problem is also compounded by the faulty evaluation practices followed, nature of the questions asked or the predictable and stereotype of questions asked in the examination. Ediger (2002) reported teacher developed tests can be more valid and reliable than standardised test and further argued that there is probably no better way to write valid test items than the classroom teacher doing the writing who knows and understands what has been taught in the classroom.

It has been observed that the achievement of students in life science subject differ significantly due to teaching by high and low competent teachers and also due to high and low teaching effectiveness of teachers (Banerjee, Das, and Mohanty, 2014). Further, a positive relationship between the teacher competence and teaching effectiveness were reported. The study was conducted amongst 564 students and 35 teachers in 21 schools of Birbhum and Burdwan districts of West Bengal. No significant difference was found due to CBSE and UP Board in the development of higher abilities of science students (Rizvi, 2014). A comparative study was made between the science students of Class XI from the CBSE board (who faced the CEE pattern in Class X) and the science student of the same class from UP board (who did not face the CCE pattern in Class X) in 2010–2011 in Bulandshahr district of UP. Chauhan (2001) reported methods for identifying under achievers in science and strategies for helping the under achievers to learn

science. Ediger, M (2013b) report Instructional Management System (IMS) as an innovative way to appraise student progress. Koul (2008) highlighted a number of evaluation issues in science. Kumar and Kumar (2011) reported a significant relationship between psychological stress and achievement of male and female students. The study was conducted amongst 631 (419 males and 212 females) senior secondary science students randomly selected from different types of institutions of Meerut district. Mohanty (2010) reported effectiveness of programmed instruction on achievement of secondary school children in life science.

Kumar and Kumar (2013) conducted a study to assess the psychological stress and its relationship with achievement of science students of Kendriya Vidyalayas and Navodaya Vidyalayas and found examination and achievement as the major factor causing stress. Agarwal (2003) identified subjectivity in marking as a major criticism in written examination and suggested a detail marking scheme to reduce subjectivity in marking. Gupta (2001) revealed variations in different sets of question papers of the same board in terms of objectives, difficulty level and content coverage leading to wide gaps in achievement level of learners for no fault of theirs. Khatoon and Sharma (2010) explored the relationship between students' personal factors (gender, religion, family background, extracurricular activities, computer and internet access) and institutional factors (school having computers and co-educational schools) with their science achievement. The study conducted on 15 year old students from a specific geographical location of western Uttar Pradesh revealed that variables such as family background, extra-curricular activities, computer and internet access, schools having computers and co-educational schools were found to be positively correlated with science achievement, but variables like gender, religion and single-sex schools have no correlation with science achievement. A study by Sharma (2008) indicated that there is a significant difference and a wide gap between the learning outcomes as expected from the curriculum and their real learning at all levels of school education.

The review revealed the low achievement of students and a grim situation regarding the assessment and evaluation system in practice. Some assessment practices reported show promise, yet no definite conclusions can be drawn. More researches in this area will definitely guide us to go in the right direction.

Environmental Concerns

Environmental concern is an important area in school education. Some studies are reported in this area. Jackson, (2001) argued that the introduction of environmental problems into existing Indian school curricula has caused incoherence as discussed in his article 'Effective Environmental Education needs 'New' Science', and stated that even the basic assumptions underlying the current science paradigm are contradicted by the solutions to environmental problems that appear to be required. Attempts are made in the textbooks themselves to remove these contradictions, but they are largely unsuccessful and only add confusion to the initial incoherence. Here, author sketches an alternative, 'New' or 'Ecological', science paradigm and suggests how it might be taught. As discussed in the article, 'Conservation of Global Biodiversity for Sustainable Agriculture' by Kulshreshtha (2000), biodiversity is the variety of the organisms existing on globe, including their genetic variability and the assemblages they form. Conservation of biodiversity is recognised as a fundamental component of sustainable development and its objective is to support sustainable development by protecting and using biological resources in such a way that do not destroy the world's variety of genes and species or vanish the important habitats and ecosystems.

Dash, Mishra and Satapathy (2010) examined the knowledge and understanding of education for sustainable development of pre-service and in-service school teachers of Odisha and reported that both pre-service and in-service teachers had moderate level of knowledge of sustainable development. However, in general, it was found that teachers were more deficient in conceptual knowledge of sustainable development (issues like indicators of economic development, carrying capacity, global climate change, biodegradation, etc.). They also reported that there was increase in their understanding of sustainable development issues with increase in teaching experience. The implications for revision of teacher preparation curriculum and organisation of community linked in-service teacher training programme to empower teachers to understand and transact sustainable development concepts have been discussed.

Experiential learning strategy yield better mean gain on environmental awareness scores as compared to the traditional method among primary school students (Mehra and Kaur, 2010)

and students with internal locus of control yield better mean gain on environmental awareness score than the students with external locus of control. Yadav and Bharati (2007) in a study conducted on environmental awareness among higher secondary students of Varanasi district in U.P reported that environmental awareness had positive relationship with scientific attitude among students and science students were found more aware about environment as compare to arts students. Vellaisamy (2010) reported that no significant positive relationship exists between achievement in environmental education and environmental awareness ability in a study conducted among Class IX students of four different schools in Vedaranyam block. It was also found that students were not having enough awareness and skills for identifying and solving environmental problem.

Nayak (2011) studied the level of awareness, knowledge and attitude of student towards climate change in B.Ed colleges of Mumbai and Navi-Mumbai. It was revealed that though student teachers of different stream, i.e., Science, Arts and Commerce were aware of the problem of climate change but they lacked sufficient knowledge of climate change with regards to its causes and consequences. Barathi, Paul and Devi (2004), in a study on environmental awareness among 296 higher secondary students in Tiruchirapalli district, found that though students have adequate environmental awareness, science students have more environmental awareness than arts and vocational students.

The Way Forward

A number of researches have been conducted mainly related to teaching of science, science curriculum, content selection in science and science teaching-learning materials. However, there are also a number of less explored areas that need attention such as epistemology of science, history and philosophy of science, and ethical and cultural issues concerned with science. Vaidya and Chunawala, in the fifth and sixth surveys, respectively, have also emphasised on studying history and philosophy of science and conducting policy studies in science education. The understanding of history and philosophy of science, epistemology of science, and ethical and cultural issues generated by science will give us an insight in designing science curriculum, teaching-learning materials and the intended pedagogical practices to be followed in teaching science. Thus, it is important that science curriculum,

teaching-learning materials including textbooks are developed keeping these perspectives in mind for improving science education. Science is a systematic and organised body of knowledge and, to teach science in its true spirit, perhaps more studies are needed in the area of scientific attitude, cognition, critical thinking, creativity and misconceptions.

References

Ahamad, N., A. Raheem and A. Hasan. 2003. Attitude of Secondary School Students towards Science in Relation to Sex, Socio-Economic Status and Intelligence. *Indian Educational Review*. 39 (2). pp. 80–89.

Ahmad, J. 2008. Scientific Attitude: Solution to all Problems. *School Science*. 46 (4). pp. 31–35.

Agarkar, S.C. and N.D. Deshmukh. 2002. How the Teacher in Ashram Schools Perceive Science Curriculum at the Upper Primary Stage. *School Science*. XL (3). pp. 68–81.

Agarwal, M. 2003. Evaluating Answer Scripts. *Journal of Indian Education*. XXIX (2). pp. 61–69.

Agarwal, P.C. 2012. Motion in Two and Three Dimensions. *School Science*. 50 (2). pp. 43–51.

Agarwal, R. and S.K. Gupta. 2010. A Study of Problem-solving Ability in Physics among Intermediate Level Students. *School Science*. 48 (3&4). pp. 56–61.

Aggarwal, I.P. 2000. Fostering Creativity through Science Teaching in Schools. *Journal of Indian Education*. XXVI (3). pp. 65–75.

———. 2003. Promoting Open Ended Learning in Chemistry— A Learner Friendly Mode. *School Science*. XLI (1). pp. 77–89.

Ajitha, N.K. and K. Pushpam. 2000. Willingness of Secondary School Teacher of Biology to use Teaching Aids. *School Science*. XXXVIII (4). pp. 58–64.

Arora, O.P., J.K. Mohapatra and B.K. Parida. 2010. Episodic Conceptualisation– A Possible Source of Alternative Conception about 'Kinetic Energy' and 'Work'. *School Science*. 48, (1&2). pp. 21–32.

Avtar, R. 2000. New Approach to Science Teaching. *School Science*. XXXVIII (2). pp. 48–55.

Awasthi, O.N. 2000. Curriculum Development: Issues and Concerns. *Journal of Indian Education*. XXV (4). pp. 115–124

Bala, N. and T. Tandon. 2009. Constructivism in Science Teaching: An emergent pedagogy. *School Science*. 47 (1). pp. 31–35.

Banerjee, S., N. Das and A. Mohanty. 2014. Impact of Teacher Competence and Teaching Effectiveness on Students' Achievement in Life Science Subject at the Upper Primary Stage. *Journal of Indian Education*. XXXIX (4). pp. 29–48.

BANSAL, G. 2014. Analysing Middle Grades Science Textbooks for their Potential to Promote Scientific Inquiry. *Journal of Indian Education*. XXXIX (4). pp. 5–21.

BAPAT, M.N. AND N.R. NAGRAJA RAO. 2002. Innovative Experiment: Verification of Boyle's Law. *School Science*. XL (2). pp. 3–7.

BARATHI, C., S. VINCENT DE PAUL AND T.K. SWANTANTRA DEVI. 2004. Study of Environmental Awareness among the Higher Secondary Students. *School Science*. XLII (1). pp. 46–53.

BASU, T. AND S. THANGASAMY. 2005. Small-group Discussion with Framing Questions on Comprehension of Concepts in Physics at Higher Secondary Level. *Journal of Indian Education*. XXX (4). pp. 72–78.

BERLINER, D.C. 2002. Educational Research: The Hardest Science of All. Educational Researcher. 31 (8). pp. 18–20.

CHANDA, K.P.S. AND N. MITRA. 2000. S. Chandrasekhar's Style of Learning: An Effective Style that May Help Others. *School Science*. XXXVIII (3). pp. 48–52.

CHAUHAN, P. 2001. Helping the Underachievers in Science. *School Science*. XXXIX(3). pp. 56–60.

CHUNAWALA, S. 2004. Education and Technology Education within the Gender Perspective. In P. Dias (Ed.), Multiple languages, Literacies and technologies (pp. 162–177). New Delhi: Multilingualism, Frankfurt and Books for Change.

———. 2006. Science education. In Sixth Survey of Educational Research 1993–2000. New Delhi: NCERT.

DAS, B.C. 2012. Effectiveness of Self-Study Material for Teaching General Science to School Students. *Journal of Indian Education*. XXXVII(4). pp. 114–132.

DASH, D., B. MISHRA AND M.K. SATAPATHY. 2010. Education for Sustainable Development. *Indian Educational Review*. 47(2). pp. 7–29.

DASH, S.K. AND D. MAHAPATRA. 2007. Evaluation of Plank's Constant using Torch Bulb and Light Emitting Diode. *School Science*. 45 (4). pp. 22–25.

DOGRA, B. 2010. Constructive Classroom Activities for Biology Learning. *Journal of Indian Education*. XXXVI(2). pp. 111–120

DWIVEDI, R.D. 2014. Effectiveness of Inquiry Training Model in Teaching Science at the Secondary School Level. *Journal of Indian Education*. XXXX(2). pp. 70–78.

EDIGER, M. 2000. Evaluating and Designing the Science Curriculum. *School Science*. XXXVIII (2). pp. 8–14.

———. 2002. Teacher Involvement to Evaluate Science Achievement. *School Science*. XL(2), pp. 60–66.

———. 2013A. Content in the Science Curriculum. *School Science*. 51(1). pp. 20–23.

———. 2013B. Innovative Evaluation Procedures in Science. *School Science*. 51(1). pp. 34–38.

GAFOOR, K.A. 2013. Differences in Students' Interest in Physics by Gender and Stage of Schooling in Kerala. *Journal of Indian Education*. XXXIX(2). pp. 99–108.

GAFOOR, K.A. AND P.T. AKHILESH. 2008. Misconception in Physics among Secondary School Students. *Journal of Indian Education*. XXXIV(1). pp. 77–90.

GAFOOR, K.A. AND V.S. JAITHRA. 2012. Influence of Out-of-School Experiences on Interest in Science of Secondary School Students in Kerala. *Indian Educational Review*. 50 (2). pp. 7–25.

GAFOOR, K.A. AND S. NARAYAN. 2010. Out-of-School Science Experiences and Interest in Science of Upper Primary School Pupils of Kerala. *Journal of Indian Education*. XXXVI (1). pp. 29–38.

GANGULI, D. AND U.C. VASHISHTHA. 1991. Research in Science Education. In M.B. Buch (Ed.), Fourth Survey of Research in Education. (pp. 711=757). NCERT. New Delhi.

GANGOLI, S.G. 2000. Transaction of Science Curriculum Using Textbooks Based on Open-Ended Approach. *Journal of Indian Education*. XXV(4). pp. 87–96.

GANGOLI, S.G. AND C. GURUMURTHY. 2013. Open-ended Experiments in Developing Cognitive Abilities. *School Science*. 51(4). pp. 13–20.

GARDNER, P.L. 1975. Attitude to Science: A Review. *Studies in Science Education*. 2. pp. 1–41.

GOSWAMI, M. AND B.K. PARIDA. 2004. Probing Understanding of Simple Harmonic Motion. *School Science*. XLII (2). pp. 63–68.

GREWAL, A. 2000. Curricular Approaches for Training in Creativity. *Journal of Indian Education*. XXVI (3). pp. 107–119.

GUPTA, A. 2010. Science Through Activities. *Journal of Indian Education*. XXXVI (1). pp. 5–19.

GUPTA, A.N. 2000A. NO^2–$N2O^4$ Equilibrium System: A Versatile Tool for Teaching Pressure Effect on Equilibrium. *School Science*. XXXVIII (4). pp. 24–26.

———. 2000B. An Easy Way to Design Inexpensive Atomic and Molecular Models. *School Science*. XXXVIII (2). pp. 56–59.

GUPTA, H.O. 2000. A constructivist enquiry learning model for science education. *Indian Educational Review*. 36 (2). pp. 5–17.

GUPTA, V.P. 2000. Nurturing Creativity through Chemistry. *Journal of Indian Education*. XXVI (3). pp. 88–96.

———. 2001. Some Issues in Public Examinations with Reference to Chemistry Paper Setting at the Senior Secondary Stage. *Journal of Indian Education*. XXVII (1). pp. 49–58.

GUPTA, V.P. AND R. RAVICHANDRAN. 2001. Study of Achievement Level of Class XI students in Chemistry — Aliphatic Hydrocarbons. *School Science*. XXXIX (3). pp. 43–55.

HAYDOCK, K. 2011. Why Do We Have Problems Learning and Teaching Science. Contemporary Education Dialogue. 8 (2). pp. 257–262.

JACKSON, M.G. 2001. Effective Environmental Education Needs 'New' Science. *Indian Educational Review*. 37 (2). pp. 22–38.

JADHAO, V.G. 2002. Teaching of Light up to Secondary Level. *School Science*. XL (2). pp. 14–20.

JAIN, H.C. 2002. Science Education for Problem Solving and Creating Thinking: A Functional Approach. *School Science*. XL (3). pp. 57–67.

———. 2011. Complexities about Simple Harmonic Motion. *School Science*. 49 (2). pp. 9–13.

JAIN, S.C. 2000. Trends in Biology Curriculum. *Journal of Indian Education*. VXXV (4). pp. 48–53.

JOGI, V.R. 2011. Participatory Video for Developing Spirit of Innovation in Socio-Economically Underprivileged High School Students. *School Science*. 49 (2). pp. 14–20.

KALA, L. AND J. RAMADAS. 2001. History and Philosophy of Science, Cognitive Science and Science Education : Issues at the Interface. *Indian Educational Review*. 37 (2). pp. 3–21.

KALIA, A.K. 2005. Effectiveness of Mastery Learning Strategy and Inquiry Training Model on Pupil's Achievement in Science. *Indian Educational Review*. 41(1). pp. 76–83.

KARTHIKEYAN, M. AND R.S. MOHIDEEN. 2005. A Study of Co-relation Between the Availability of Physics Laboratory Facilities in Higher Secondary Schools and their Utilisation. *School Science*. LXIII (1). pp. 74–81.

KAUR, G. 2010. Disaster Management as a Component in School Curriculum. *School Science*. 48 (3&4). pp. 62–66.

KHARATMAL, M. 2009. Concept Mapping for Eliciting Students Understanding of Science. *Indian Educational Review*. 45 (2). pp. 31–43.

KHATOON, T. AND M. SHARMA. 2010. Personal and Institutional Factors and their Influence on Science Achievements. *Indian Educational Review*. 46 (1). pp. 86–100.

KISHORE, L. 2000. Incorporating Value Education in Science Teaching. *School Science*. XXXVIII (1). pp. 92–96.

———. 2002. Lecturing and Rote-Learning Leading to Misconceptions in Physics. *School Science*. XL (4). pp. 43–45.

———. 2003. Sound and Wave Motion Concepts at the School Level with Soda Straws: Some Inexpensive Demonstrations. *School Science*. XLI (1). pp. 51–52.

———. 2004. Masculine Image of Physics: Breaking the Mould for Attracting Girls to Physics Courses. *School Science*. XLII (4). pp. 95–97.

———. 2006. Learning Science Hands-on way with Discarded Plastic Bottles and Polythene Bags. *School Science*. 44 (4). pp. 48–53.

KISHORE. L. AND T. TAMHANE. 2013. Teaching the Effects of Force at Grade Level VI: Textual Activities versus Hands-on Activities. *School Science*. 51 (4). pp. 21–25.

KOUL, A. 2008. Evaluation in Science Quality Issues. *School Science*. 46 (4). pp. 17–23.

KULKARNI, V.G. 2013. Vital Concerns in Curriculum Development in Science and Mathematics. *School Science*. 51 (1). pp. 24–29.

KULSHRESHTHA, P. 2000. Conservation of Global Biodiversity for Sustainable Agriculture. *School Science*. XXXVIII (2). pp. 76–80.

KUMAR, D.D. 2013. Classroom Variables and Student: Attitude towards Science. *School Science*. 51 (1). pp. 39–45.

KUMAR, N. AND R. KUMAR. 2011. Psychological Stress in Relation to Achievement among Male and Female Science Students. *Journal of Indian Education*. XXXVII (3). pp. 57–63.

———. 2013. Psychological Stress and its Relationship with Achievement of Science Students of Jawahar Navodaya Vidhyalayas. *Journal of Indian Education*. XXXVIII (4). pp. 84–90.

———. 2013. Psychological Stress and its Relationship with Achievement of Science Students of Kendriya Vidyalayas. *Journal of Indian Education*. XXXVIII (2). pp. 44–50.

LAKSHMINARAYANA, U. AND E. SREEKALA. 2001. A Study of Class VII Students' Understanding of Science and their Process Skills in Relation to Ability to Apply Science in Daily Life. *School Science*. XXXIX (4). pp. 70–77.

———. AND P.R. LALITHA. 2002. Study of Attitude of +2 Students towards Physics Laboratory Work. *School Science*. XL (2). pp. 45–53.

LAMBHATE, M.V. AND U.S. CHOUDHARI. 2013. Bullock-Cart: A Laboratory for Science Teaching. *School Science*. 51 (4). pp. 9–12.

MALI, P. 2001. Buoyant Force and its Relation to the Fluid Pressure. *School Science*. XXXIX (1). pp. 21–24.

MAITRA, S.N. 2009. Projectile Motion of Cricket Ball: Caught Out Batsman in Cricket Game. *School Science*. 47 (3&4). pp. 75–78.

MATHAI, S. AND J. RAMADAS. 2009. Visuals and Visualisation of Human Body Systems. *International Journal of Science Education*. 31 (3), pp. 439–458.

MEHRA, V. AND J. KAUR. 2010. Effect of Experiential Learning Strategy on Enhancement of Environmental Awareness among Primary School Students. *Indian Educational Review*. 47 (2). pp. 30–44.

———. AND H.R. MONDAL. 2005. Effects of Peer Tutoring on Learning Outcomes of High School Science Students. *Indian Educational Review*. 41(1). pp. 41–58.

MEHROTRA, A. AND A. KOUL. 2012. Is Teaching-Learning of Mole Concept Really Difficult? *School Science*. 50 (2). pp. 21–33.

MEHROTRA, I. AND V. BANIWAL. 2006. Understanding 'Children's Construction of Biological Concepts' and its Educational Implications. *School Science*. 44 (3). pp. 39–54.

MODY, A.K. 2011. Construction of Knowledge and Development of Multiple Intelligence Teaching and Assessing through PBL. *School Science*. 49 (1). pp. 34–41.

———. AND H.C. PRADHAN. 2011. Problem-based Learning in Basic Physics-1. *School Science*. 49 (3). pp. 3–9.

MODI, A.K. AND H.C. PRADHAN. 2011. Problem-based Learning in Basic Physics-II. *School Science*. 49 (4) & 50 (1). pp. 29–35.

———. AND H.C. PRADHAN. 2011. Problem-based Learning in Basic Physics-III.*School Science*. 49 (4) and 50 (1). pp. 36–42.

MODY, A.K. AND H.C. PRADHAN. 2014. Problem-based Learning in Basic Physics-IV. *School Science*. 52 (1). pp. 35–43.

MOHANTY, G. AND S.C. PANDA. 2009. Learners' Engagement in Secondary School Bioscience Activities: An Analysis. *School Science*. 47(3&4). pp. 65–74.

———. 2012. The Secondary School Biological Science Curriculum of Odisha: A Critical Study. *Journal of Indian Education*. XXXVIII (1). pp. 108–115.

MOHANTY, K. 2010. Effect of Programmed Instruction on Achievement of Secondary School Children in Life Science. *School Science*. 48 (3&4). pp. 40–55.

NCERT. 2005. *National Curriculum Framework 2005*. New Delhi.

———. Position paper on Teaching of Science 2005. New Delhi.

———. 2017. *National Achievement Survey (NAS), Classes 3, 5 and 8.* New Delhi.

———. 2018. *National Achievement Survey (NAS), Class X, Cycle-2.* New Delhi.

NAYAK, J. 2011. An Investigation into the Awareness, Knowledge and Attitude of Student Teachers towards Climate Change. *Indian Educational Review*. 49 (2). pp. 54–63.

PACHAURY, A.C. 2000. Logical Thinking in Biology and Chemistry Post-Graduate Teacher. *School Science*. XXXVIII (2). pp. 60–66.

———. 2006. Science Student– Teachers' Reflection upon Intellectual and Procedural Honesty on Conducted Practicals. *School Science*. 44 (3). pp. 86–88.

PADHI J.S. 2013. Relationship between Academic Self-concept in Science and Cognitive Preference Style. *School Science*. 51(1). pp. 49–53.

PAL, G.C. 2000. Students' Understanding of Science and Technology. *School Science*. XXXVIII (3). pp. 29–35.

PANCHAPAKESAN, N. 2006. Assessment of Learning and Acquisition of Scientific Temper. *School Science*. 44 (2). pp. 26–31.

PANT, D. 2006. Contents of Science Textbooks vis-a-vis Learning of Science. *Journal of Indian Education*. XXXII (1). pp. 15–23.

PANT, M. AND K. MAITRA. 2002. Understanding Talent in Science Classroom – An Exploratory Study. *School Science*. XL (3). pp. 90–102.

PAREEK, R.B., T.J. VIDYAPATI AND A.K. ARYA. 2012. Impact of Microscale Laboratory Kit on Students' Achievement in Chemistry Practical. *School Science*. 50 (2). pp. 12–20.

PARIDA, B.K., M. MAHAPATRA AND M. GOSWAMI. 2000. Alernative Conceptions of Pupils in Gravitation. *School Science*. XXXVIII (2). pp. 67–75.

———. 2000. Using Analogy as a Tool in Science Education. *School Science*. XXXVIII (4). pp. 48–57.

PARKASH, P. 2000. Assessing Toxicity of Nitrates and Nitrites. *School Science*. XXXVIII (1). pp. 14–15.

PRABHA, S. 2010. Characteristics of a Constructivist Classroom in the Context of Science Education. *Journal of Indian Education*. XXXVI (1). pp. 20–28.

PRAVEEN, D.T. 2012. Effectiveness of Tree-chart for Teaching Botany at Higher Secondary Level. *School Science*. 50 (2). pp. 4–11.

RAJKUMAR, S. 2010. The Role of Metacognition in Learning and Teaching of Physics. *School Science*. 48 (1&2). pp. 48–53.

RAMADAS, J. 2009. Visual and Spatial Modes in Science Learning. *International Journal of Science Education*. 31(3). pp. 301–318.

RATNA, V. 2001. Measuring Focal Length of a Lens of Low Power Using a Laser. *School Science*. XXXIX (1). pp. 3–8.

RAVEENDRAN, A. AND S. CHUNAWALA. 2015. Reproducing Values: A Feminist Critique of a Higher Secondary Biology Textbook Chapter on Reproductive Health. *Indian Journal of Gender Studies*. 22 (2). pp. 194–218.

RAVICHANDRAN, R. AND P. SASIKALA. 2010. Nanoscience Curriculum in School Education: Intergrating Nanoscience into the Classroom. *School Science*. 48 (1&2). pp. 33–42.

RIZVI, N. 2014. 'Effectiveness of Continuous and Comprehensive Evaluation (CCE) on the Development of Higher Mental Abilities in Science Students'. *School Science*. 52 (1). pp. 66–71.

SACHETI, A.K. AND V.S. MEHROTRA. 2000. Introducing Agriculture as a Compulsory Component of Science in School Curriculum. *Journal of Indian Education*. XXV (4). pp. 68–72.

SAMINATHAN, B. AND S. MOHAN. 2002. Facilitating Learning Physics among Higher Secondary Students. *School Science*. XL (4). pp. 54–67.

SAXENA, A.B. 2001. A Study of Teacher's Understanding of Basic Concepts of Physics. *School Science*. XXXIX (1). pp. 39–45.

SEETHARAMAPPA, J. 2012. A Game on the Periodic Table. *School Science*. 50 (3&4). pp. 99–105.

SENGUPTA, M. 2001. Concept Learning in Science. *School Science*. XXXIX (3). pp. 30–33.

SENGUPTA, D. AND C. CHAKRABORTY. 2005. Evidence of Scientific Reasoning: A Cross-Grade Study. *School Science*. XLIII (4). pp. 25–28.

SHAFFI, S.A. 2000. Problem-Solving Activities for Senior Secondary Biology Students. *Journal of Indian Education*. XXVI (3). pp. 81–87.

———. AND R. RAVICHANDRAN. 2002. Integrating Critical Thinking Skills in the Classroom. *School Science*. XL (2). pp. 34–39.

SHAILJA, H.M. 2009. Effect of Concept Mapping Strategy in Physics on Achievement and Attitude of Students. *Indian Educational Review*. 45 (2). pp. 106–107.

SHARMA, K. 2014. Effect of Concept Mapping Strategy on Achievement in Organic Chemistry for Class XII Science Students. *School Science*. 52(1). pp. 17–34.

SHARMA, K. AND M. PATEL. 2006. Science Laboratory at Secondary Level: A Comparative Study of Availability and its Usage in Perception of Jawahar Navodaya Vidyalaya and SC/ST School Teachers. *School Science*. 44 (1). pp. 68–75.

SHARMA, R. 2002. Assessment of Science Practical Skills of Students at Secondary Level. *School Science*. XL (3). pp. 103–106.

SHARMA, S.P. AND A. SINGHAI. 2000. Cognitive Conflict Studies Among Secondary School Children in Physics. *School Science*. XXXVIII (4). pp. 27–35.

SHARMA, S.V. 2007. Concept of Force Across Different Levels. *School Science*. 45 (1). pp. 49–63.

———. 2008. A Study of Students' Ideas about Understanding the Basic Concepts of Optics. *School Science*. 46 (4). pp. 41–59.

———. AND K.C. SHARMA. 2003. A study of Teacher's Understanding of Basic Concepts of Physical Optics. *School Science*. XLI (3). pp. 36–47.

SHUKLA, R.D. 2000. Electrode Potential for Predicting the Products of the Reactions. *School Science*. XXXVIII (3). pp. 9–14.

SINDHU, R.S. AND R. SHARMA. 2000. A Study on Misconceptions and Errors of Students Found in Naming the Complex Compounds. *School Science*. XXXVIII (4). pp. 43–47.

———. AND R. SHARMA. 2002. Practical Methods for the Analysis of Environment Pollutants. *School Science*. XL (4). pp. 37–42.

SINGH, A. 2000. Improving Physics Learning Through Error Analysis.*School Science*. XXXVIII (1). pp. 33–41.

SINGH, S. 2013. Education in Physics for Rural Children. *School Science*. 51 (4). pp. 26–31.

SINGH, T.B. 2006. A Study of Existing Facilities of Science Teaching in the High Schools of Chhimtuipui District, Mizoram. *Journal of Indian Education*. XXXII (3). pp. 117–124.

SMITHA, V.P. AND M.P. RAO. 2009. Effectiveness of Guided Discovery Learning on Critical Thinking of Secondary School Students. *School Science*. 47 (1). pp. 50–57.

SOOD J.K. AND A. SARASWAT. 2011. Teaching the Nature of Science: Restructuring Science Instruction. *School Science*. 49 (4) and 50 (1). pp. 50–57.

SRIDEVI, K.V. 2013. Effects of Constructivist Approach on Students' Perception of Nature of Science at Secondary Level. *Artha Journal of Social Science*. 12 (1). pp. 49–66.

TANDON, T. 2011. Story-telling– A Constructivist Tool in Science Teaching. *School Science*. 49 (2). pp. 4–8.

VAIDYA, N. 1997. Science education. In Fifth Survey of Educational Research 1988–92. NCERT, New Delhi.

VELLAISAMY, M. 2010. A Study of Environmental Achievement in Class IX Students through Environmental Awareness. *Indian Educational Review*. 47 (2). pp. 72–82.

VIDYAPATI, T.J. AND T.V.S. PRAKASA RAO. 2003. Gender and Socio-Culture Differences in Scientific Attitude, Creative Ability and Science Achievement of Ninth Graders. *Journal of Indian Education*. XIX (1). pp. 58–67.

YADAV, P.S. AND A. BHARATI. 2007. A Study of Relationship between Environmental Awareness and Scientific Attitudes among Higher Secondary Students. *Journal of Indian Education*. XXXIII (2). pp. 59–69.

Research Papers

What Guides Inference Generation? A Study of Young Hindi Learners Studying in Challenging Contexts in India

*Lina Mukhopadhyay, **Vasim Salim Tamboli, ***Kankan Das, ****Anusha Balasubramanian and *****Ianthi Maria Tsimpli

Abstract

In a vast multilingual country like India, primary education is offered in various languages as Mediums of Instruction (MoI) to support the state languages and foster social justice in education. An important milestone of primary education is to help learners develop comprehension skills in MoI to process information and lay a strong foundation for education. Comprehension involves 'inference generation skill' that helps learners formulate multiple possible answers. Teaching and assessment in India have a product-based content testing approach and teachers are not trained to deal with individual differences in responses in a constructive manner. In this paper, learners are assessed in oral and print mode to understand what gives rise to individual differences in comprehension through Hindi as MoI. A group of 30 bi or multilingual learners, 7 to 12 years old, attending Class IV in state run primary schools in Bihar (India) participated in the study. A quantitative analysis of learner performance shows that inference generation is affected by

*Professor, English as Foreign Lanuages University, Hyderabad (e-mail: linamukhopdhayay@efluniversity.ac.in).

**MultiLiLa Research Associate, The English and Foreign Languages University, Hydrebad.

***Assistant Professor, Department of English Studies, Christ (Deemed to be University), Bengaluru.

****Postdoctoral Research Associate at the University of Cambridge, Cambridge

*****Professor and Chair of English and Applied Linguistics at the University of Cambridge and Fellow of Fitzwilliam College, Cambridge.

modality (oral or print), gender and the complexity of inferences. A qualitative analysis of individual variations shows that of the total number of inappropriate responses to comprehension questions, many refer to experiential or world-knowledge inferences but fail to link them to the specific story-based information. This indicates difficulties with inference generation and the ability to select only the relevant parts of the response. The findings have implications for pedagogical methods of promoting inference generation skills using world knowledge in combination with text-based information to offer meaningful feedback.

Keywords: *Narrative comprehension, Medium of Instruction (MoI), inference generation, propositional inference, pragmatic inference, world knowledge.*

सार

भारत जैसे विशाल बहुभाषी देश में स्थानीय भाषाओं को महत्व देने हेतु प्राथमिक शिक्षा स्थानीय राज्य की भाषाओं में प्रदान की जाती है, ताकि शिक्षा में सामाजिक न्याय को बढ़ावा दिया जा सके। प्राथमिक शिक्षा का एक महत्वपूर्ण आयाम सूचनाओं को संसाधित करने और शिक्षा के लिए मजबूत नींव रखने हेतु शिक्षार्थियों की शिक्षण के माध्यम में 'समझ कौशलों' को विकसित करने में मदद करना है। इस समझ में 'अनुमान जनन कौशल' शामिल है जो शिक्षार्थियों को कई संभावित उत्तर प्रतिपादित करने में मदद करता है। भारत में शिक्षण और मूल्यांकन उत्पाद-आधारित सामग्री परीक्षण उपागम पर निर्भर है और शिक्षकों को रचनात्मक तरीके से प्रतिक्रियाओं में व्यक्तिगत भिन्नताओं से निपटने के लिए प्रशिक्षित नहीं किया जाता है। इस शोध पत्र में, शिक्षार्थियों का मौखिक और प्रिंट माध्यम से परीक्षण किया गया जिससे यह ज्ञात हो कि मातृभाषा हिंदी द्वारा समझ विकसित करने के कारकों का ज्ञान हो सके। बिहार राज्य में संचालित प्राथमिक विद्यालय के कक्षा IV में पढ़ने वाले 7 से 12 वर्ष की आयु के 30 बहुभाषी शिक्षार्थियों के एक समूह ने इस अध्ययन में भाग लिया। शिक्षार्थी के निष्पादन का मात्रात्मक विश्लेषण दर्शाता है कि साधन (मौखिक या प्रिंट), लिंग और अनुमानों की जटिलता से अनुमान जनन प्रभावित होता है। व्यक्तिगत विभिन्नताओं के गुणात्मक विश्लेषण से पता चलता है कि समझ से संबंधित प्रश्नों के प्रति अनुचित प्रतिक्रियाओं की कुल संख्याओं में से कई अनुभवात्मक या विश्व-ज्ञान के संदर्भों का उल्लेख करते हैं लेकिन उन्हें विशिष्ट कहानी-आधारित जानकारी से जोड़ने में विफल रहते हैं। यह अनुमान जनन और उत्तरों के केवल प्रासंगिक भागों का चयन करने की योग्यता के साथ जुड़ी कठिनाइयों को बताता है। अध्ययन के परिणाम अर्थपूर्ण प्रतिपुष्टि प्रस्तुत करने के लिए पाठ-आधारित जानकारी के साथ विश्व ज्ञान का उपयोग करके अनुमान जनन कौशलों को बढ़ावा देने के हेतु शैक्षणिक विधियों का उपयोग करने पर बल देता है।

Introduction

In a vast multilingual country like India, primary education is offered in different languages as Mediums of Instruction (MoI) to support the state languages and foster social justice in education (Mohanty 2018; Enever 2018). However, a country that has a vast linguistic diversity with 462 spoken languages, MoI is available only in 31 languages, and has been reduced from 67 languages in the 1970s, as reported in a study by Meganathan (2011).

A large number of Indian schools, run by central or state governments, at the primary level offer at least two or three languages. But learning needs to happen mostly through the medium of instruction. Many learners from low SES families fail to reach grade appropriate comprehension skills in MoI because there is less or no overlap between home and school language, which creates a linguistic barrier and leads to poor learning outcomes. This has been widely documented in the recent years by ASER survey reports (Pratham, 2014, 2017) and research in Indian classrooms (Meganathan, 2011). Another critical learning problem came out in recent research in Indian classrooms is that independent study skills are underdeveloped because the classes are teacher-centric with a lot of read aloud and repetition exercises and assessment being based on rote learning of prescribed answers to questions that test content knowledge (Alcott and Rose, 2017; Banerji, 2017; Lightfoot et al., submitted). Furthermore, since children and teachers are multilingual, language mixing in classrooms is an often pedagogical strategy, though much of the multilingual practices are not planned to support learning the target language; they largely stay at the level of literal translation (Clarke, 2001, 2003; Wei, 2017; Brinkmann, 2018; Mathew et al., submitted). So both home environment and classroom practices are not conducive to the development of knowledge of MoI in children from low SES families (Jhingran, 2009; Mohanty, 2018).

Challenges in Developing Comprehension Skills in Primary Schools in India

Primary schools running by state governments in India frequently face the challenge to develop comprehension skills in the medium of instruction (MoI). Language textbooks contain a higher number of narratives and a few expository texts that serve as inputs based on which decoding and comprehension skills in the MoI are

expected to develop. Comprehension is an important school skill as it helps learners process information and understand concepts across subjects and lay a strong foundation of education. However, to develop comprehension skills it becomes incumbent on one's vocabulary, phonological awareness and morpho-syntactic knowledge in the Medium of Instruction (MoI) as well as word decoding skills. A majority of the urban poor and rural Indian children who come from low SES families live in multilingual environments, but their parents are not able to support them with literacy practices at home. Quite naturally their academic proficiency in MoI is low and development of higher order study skills such as decoding and comprehension, either oral or print, is negatively affected (Jhingran, 2005).

In addition to low proficiency in MoI, another factor that hinders development is instructional and assessment practices. Indian teachers in low cost government schools are found to heavily depend on textbooks and focus more on memorisation of factual information, read aloud sessions and translation of content instead of developing independent comprehension and critical reading skills (Clarke, 2003; Banerji, 2017; Mukhopadhyay et al., 2020). Indian school education policy documents bring out the lack of transacting knowledge through comprehension in class. A compelling document identifying that 'the load of non-comprehension' in school going Indian children 'is a pernicious burden' causing poor quality of education was brought out in the 1993 government of India report, Learning Without Burden (also known as Yashpal Committee Report). Similar arguments echo in the *Position Paper of the National Focus Group on Indian Languages* and *Position Paper on the National Focus Group on English* (NCERT, 2006), and the *National Curriculum Framework* (*2005*). Poor word decoding and reading comprehension outcomes have also been reported by ASER studies conducted with 6,00,000 children across India. The ASER reading test has shown that more than half of all children in Class V could not read a Class II level text fluently (Pratham, 2017). This results in poor learning outcomes and school dropouts, affecting girls more than boys (*Unesco's Education Report*, *2015*). In practice this problem continues to impact students in low cost government schools. This paper makes an attempt to study critical issues in the development of comprehension ability of learners in schools that have Hindi as the medium of instruction

in the state of Bihar. The study would look at comprehension difficulties of young Indian learners who are from low SES families and lack literacy exposure and parental support at home.

Assessing Comprehension

Successful comprehension, either in the oral or print mode, involves a higher-level skill—inference generation—which allows learners to develop a deeper understanding of the text. It helps in expanding and paraphrasing messages in more than one way, learning to understand new content, and make connections between old and new information. As teaching and assessment in India are largely approached as product based learning (Clarke, 2003; Chand, 2011; Smith et al., 2005), teachers are not always trained to assess learners' comprehension skills in a constructive manner. So they fail to draw estimates of individual differences in comprehension levels. Thus, when learner responses do not match the teacher key, they are often considered erroneous and therefore discarded (Brinkmann, 2018; Milian Winch, 2019). It is essential for teachers to appreciate that being able to infer is proof of growth in the learner's cognitive-linguistic skills because they can now 'access' and 'generate' ideas to fill-in information that is implicit or unsaid in a text (Kendeou, 2015; Cain et al., 2001). It also enhances a child's social cognition, as inferences can be guided by their experiential knowledge helping her assign mental states to herself and others (Astington and Jenkin, 1995). So, inference generation skills are likely to give rise to individual differences in comprehension skills and most importantly teachers need to recognise and handle such differences effectively.

Assessing individual differences in comprehension skills and improving pedagogical practices to develop such skills has been a neglected area of research in the Indian context. This paper attempts to explore this gap by assessing comprehension skills and analysing variations in responses to understand how to give feedback to develop inference generation skills. So, in this paper individual differences in comprehension will be examined in primary level low SES Indian children for the first time. Through an in-depth analysis of learner attempts to derive inferences within a range of variation from the constructed key of the narrative tool, the paper in a novel approach aims to also raise teacher awareness of how variation in individual responses can provide material for constructive, meaningful feedback.

The MultiLiLa Project

Recent research in India led by the University of Cambridge in collaboration with Indian universities has revealed that children from low SES and challenging contexts have better learning outcomes when the MoI overlaps with at least one of their home languages (Tsimpli et al., 2020). This research is carried out within the Multilingualism and Multiliteracy (MultiLiLa) project (Tsimpli et al, 2019) which aims to increase awareness and knowledge about the link between learning levels of literacy and numeracy, cognitive abilities and the languages of instruction that multilingual children in India are exposed to. The project is a four-year longitudinal study, beginning in 2016, and operates across three research sites— Delhi, Hyderabad (Telangana) and Patna (Bihar). In addition to administering a series of language, numeracy and cognitive tasks to the children, the project also involves observations of lessons in the schools these children attend. Broadly, these observations seek to explore within 30 minutes of lessons— (i) what languages are being used by the teacher and the learners, (ii) at what stages during the lesson and (iii) accompanying what types of activities.

Evidence from the MultiLiLa project from language comprehension, oral and written, of a large cohort of 498 learners in Class IV enrolled in Hindi MoI schools in Patna and in Delhi has revealed interesting discrepancies between the two modalities. The children were tested on reading comprehension using the ASER literacy tool, which was supplemented with two novel comprehension questions about a story corresponding to the highest level of reading skill. The results from the reading assessment show that learners show good letter and word decoding skills (85 per cent accuracy) but drop in sentence and text reading (72 per cent) while score lowest in story comprehension (67 per cent) (Balasubramanian et al., 2020). In the same study, the same cohort of children was tested in oral comprehension skills using picture-retelling tasks taken from the MAIN manual (Gagarina et al., 2012). In contrast to reading comprehension scores, oral narratives showed better comprehension skills.

The present study focuses on a small set of 30 children from the larger cohort of children studying in Patna schools with the aim to compare narrative oral comprehension with reading

comprehension responses more closely. The study focuses on inference generation, a higher order comprehension skill, and how children use a combination of text-based situation model and world knowledge to draw inferences (Perfetti and Stafura, 2015).

Inference Generation

During reading, the reader constructs meaning at various levels, which might be accurate or near accurate with respect to the text's content (Chikalanga, 1992; Cain et al., 2001). Text understanding is reflected through a variety of inferences according to the learner abilities to make connections between ideas presented in a text (text-based inferences) or to retrieve and connect background knowledge (from long term memory) during the meaning making process (world knowledge based inferences). Thus, inference generation involves three cognitive processes— (a) access background or world knowledge, (b) integrate it with text information to (c) generate links that are not explicitly stated in the text (Kendeou, 2015; Cain et al., 2001; Perfetti and Stafura, 2015).

Inference generation can be further subdivided to help language teachers design questions for assessing this skill by taking into account different comprehension needs and levels of learners. To substantiate this need of designing inference generation questions at different levels of complexity, Chikalanga proposes inference generation taxonomy with two categories (p. 698):

- Propositional inferences (ProIs) also called text-based inferences are considered 'true-inferences' because these are generated from the content of the text. ProIs are 'convergent' in nature since only one acceptable answer is available based on the linguistic input provided in the text; thus within a contextual setting or story structure, disagreements on ProIs are less likely.
- Pragmatic inferences (PraIs) or world knowledge based inferences, on the other hand, are considered 'not always true' because they depend upon prior knowledge or world experience which are arbitrary; PraIs are 'invited inferences' as these inferences are beyond the linguistic input given in the text, and 'divergent' in nature since there is always a possibility of more than one answer or variation in the inferences because of prior knowledge, individual differences, and shared communicative context.

Since PraIs rely upon the understanding of both the text and the context of the text, they involve a higher level of cognitive

processing. This is also one of the reasons that PraIs are more difficult than inferences that are ProIs. Therefore, although PraIs are considered 'not always true', they can assess learners' higher level of meaning making abilities while comprehending a text. But such inferences can also give rise to individual differences in inference generation abilities.

Assessing Inference Generation Abilities

The human mind has information about people, actions, events, objects, nature and abstract concepts. This information is based on a person's family, social and academic experience and referred to as one's world knowledge structure. This knowledge contributes to one's inference generation abilities. While comprehending a text on a familiar topic, a reader derives world knowledge based inferences as they relies on various information sources like prior knowledge or real-world experience.

Similarly, the reader forms a situation model, i.e., constructs a micro-world of the text information with links in between ideas (e.g., characters, actions, events), which helps to select and track what is important in the text to comprehend. This creation of a micro-world resembles everyday experience from the real-world which nobody can take away or detach the reader from. As a result, if these structures are activated in the process of text comprehension and the reader incorporates world-knowledge related content, chances are higher for accurate text-based inference to take place (Perfetti and Stafura, 2015). Therefore, to aid learners' comprehension abilities, the key assumption is the need to create a substantial number of inference generation opportunities to help them make a rich representation of the text in mind. Also, to validate the inferences generated by learners by reflecting on their world knowledge structures, there is a need to create or use tasks that account for their world knowledge as well as take into account different responses of learners (Aukerman et al., 2017). Using a verbal protocol analysis to understand learners' engagement with their thought processes (Cote et al., 1999), asking them questions to have an estimate of their understanding of the text in parts (Long and Golding, 1993), and assessing representation of story grammar in the extended text (Gagarina et al., 2012; Taylor 2013) are a few ways to assess skills of both propositional and pragmatic inferences.

To summarise, in using inference generation learners are likely to show individual differences and it is crucial for teachers to

gain awareness about how to accommodate variations in learner responses to recognise different levels of these abilities and provide meaningful feedback (Cain et al, 2001; Aukerman et al., 2017). This paper presents, through an in-depth analysis of learner responses, how individual differences in inference generation can be identified and treated.

The Study

The study reported here is part of the four year MultiLiLa project presented above. Here we report on the comprehension of 30 Hindi speaking learners studying in four primary schools in Patna, the capital of Bihar, India. In Bihar state, Hindi is the local language, although people also speak Magahi, Maithili, Bhojpuri, and Urdu, which make many of the learners bi or multilingual (44 per cent).

Research Questions

The study addresses the following research questions:

1. Do language comprehension questions presented in the oral and the print modality help learners generate inferences equally well?
2. Do comprehension skills differ in boys and girls?
3. Do learner responses vary across different types of inference generation?
4. Are there individual differences in inference generation for narrative comprehension and if so, which are they?

Method

Participants

Thirty learners (M=16; F=14) from Class IV participated in this study. Their age ranges from 8 to 11 years (mean age = 9.44; SD = 0.89). Of the 30 learners, 27 reported as Hindi to be their L1 (90 per cent), while 1 reported Bhojpuri (3 per cent) and 2 reported Urdu (6 per cent) to be their L1. Note that though 90 per cent of the children reported that they speak hindi at home, the variety is different from the standard variety used as MoI in schools they are enrolled. The variety of hindi used for school instruction is considered '*shudh*' or standard and the learners are expected to develop academic proficiency in it. The absence of use of standard variety of hindi and use of other dialectical variations of it at home is likely to create a gap between home and school language and

this may put the children at a disadvantage. Of the 30 learners, 13 learners (44 per cent) used more than one language at home, whereas 17 learners (56 per cent) stated they knew only one language, namely hindi.

Table 1: Learner profile

City (State)	Medium of Instruction (MoI)	Number of Children (N)	Age (Range in years)	Age Mean (SD)	Child bilingualism	MoI (Hindi) overlap with home language	Parent occupation (with literacy practices)
Patna (Bihar)	Hindi	30 (F=14; M=16)	8 years 4 months to 11 years 8 months	9.44 (0.89)	44 %	100%	53.33%

In the study, a child questionnaire was used with subsections on child bilingualism and on socio-economic details and it was found that the learners were from lower socio-economic (SES) background families whose parents work mostly as daily labourers, vegetable vendors, auto rickshaw drivers and so on. These professions are without much involvement of literacy practices and serve as a low indicator of parental literacy.

Tasks Used

Narrative Comprehension Task

The Cat Story from the MAIN (Gagarina et al., 2012, pp. 111–117) was adapted to an informal oral variety of Hindi and an Indian male voice was used to record the audio input. The story had a setting (time and place) and three short episodes each comprising story structure elements such as—Goal, Attempt and Outcome. The three episodes were presented through a sequence of three picture panels and each panel had two pictures in it. So, the three episodes were depicted through six pictures (refer to Appendix 1 for the story details). The story had nine comprehension questions to draw upon inference generation abilities (refer to Table 5 in Appendix 1).

For assessing comprehension skills, scoring sheet was used to assess performance on the comprehension questions and the key provided in the MAIN manual (refer to Tables 2 and 3 below).

These comprehension questions were in sync with story structure elements (refer to Table 5 in Appendix 2). For example, three questions (Questions 1, 3 and 4) targeted three goals (Cat, Boy, and Cat). The other six questions elicited answers around internal state terms, i.e., terms expressing physiological (e.g., hungry, thirsty), perceptual (e.g., see, hear), emotional (e.g., happy, sad), linguistic (e.g., say, tell), mental (e.g., think, believe) and consciousness terms (e.g., alive, awake, asleep) (see Gagarina et al, 2012 for details).

For the purpose of examining two types of inference generation, the questions were classified into two categories:

- Propositional inference (ProI): Questions 1, 2a, 3, 4, and 5a
- Pragmatic inference (PraI): Questions 2b, 5b, 6a, and 6b

The comprehension questions to which answers can be logically derived from the audio and video input were classified as propositional inference. For example, for Question 3 (Why does the boy hold the fishing rod in the water?) the answer can be logically derived from the text (At the same time the boy began pulling his ball out of the water with his fishing rod). The comprehension questions which did not have explicit answers in the audio text are categorised under the PraI category. For example, Question 6b (Imagine that the boy sees the cat, how does the boy feel?) does not have its explicit answer in the linguistic input provided in the text.

The researcher read out the questions to each learner in hindi one at a time and participants answered in the same language. If any answers or responses were not convergent with the answer key, the researchers noted down such responses under the comment section in the scoring sheet. Based on the differential answers provided by the children in response to the questions, we will analyse these answers and consider if such answers can be improved with the help of feedback.

ASER Literacy Task

The ASER literacy tool in hindi (Pratham 2014, 2017) was used which measures: letter naming (10 items), single word reading (10 words), reading of sentences (4 sentences), reading of a story (9 sentences), and two novel propositional inference questions (2 questions). This paper reports, results from the two propositional inference questions each carrying one mark.

Results

Results on learner performance according to the four research questions (RQs) are reported.

Research Question 1 and 2: Impact of modality and gender on comprehension

Learner performance on narrative comprehension across two modalities—oral and print (ASER test) in boys and girls are presented in Figure 1.

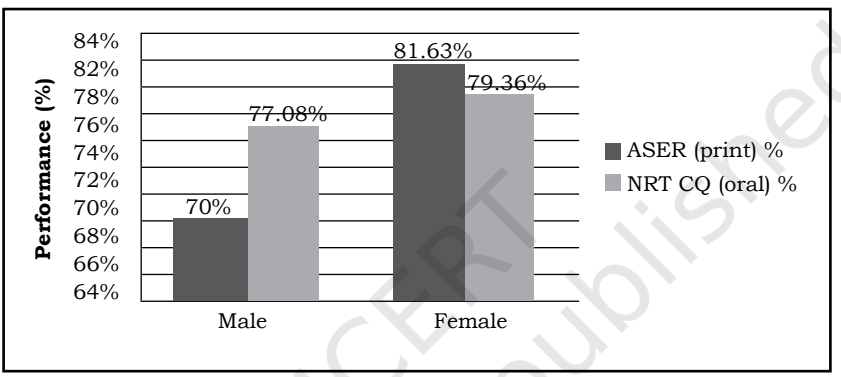


Figure 1: Performance on ASER test and oral narrative comprehension

Figure 1 shows a gender effect on narrative and reading comprehension scores. Specifically, girls performed better at 81 per cent than boys at 74 per cent across oral and written modality although this difference was not found to be significant on a one way within group ANOVA test (Gender X Test type) on the ASER comprehension (df =1.28, F =0.109, p<0.74) or the narrative comprehension (df =1.28, F = 0.802, p<0.37) tasks. Performance on narrative comprehension (78.14 per cent) was higher than performance on reading comprehension (75.42 per cent); this difference was found to be significant on a t-test (df=29, t= 23.05*, p<0.05). But performance in the two tasks was not correlated (r = 0.05, n.s.) meaning that a higher level of oral comprehension did not predict better performance in print comprehension, contrary to previous findings that oral skills correlate with print skills corroborating the simple view of reading (Cain et al. 2001).

Research Question 3: Impact of levels of difficulty of inference on comprehension

Learner performance on narrative comprehension under two types— (i) propositional inference and (ii) pragmatic inference are compared with (iii) propositional inferences from the ASER test and presented in Figure 2.

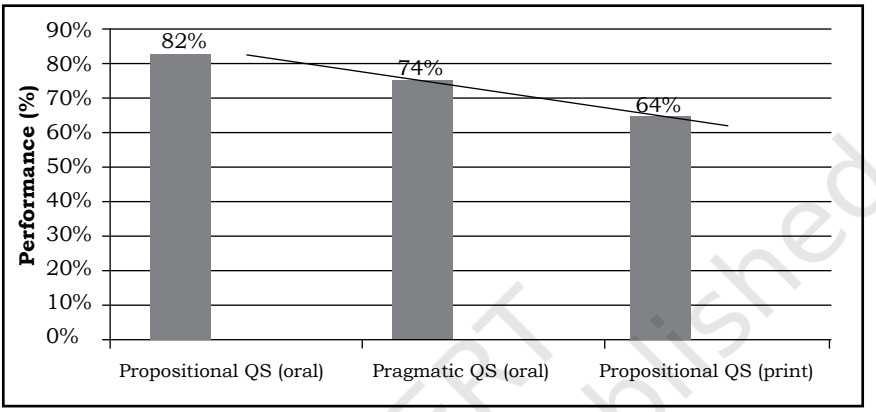


Figure 2: Performance on propositional (oral vs print) and pragmatic inference

Propositional inferences in the narrative task was highest (82 per cent) followed by pragmatic inferences in the same task (74 per cent) while lowest performance was in propositional inferences in the reading task (64 per cent). The three measures significantly differed in a one-way GLM repeated measures test (1X1X1: inference type) (df=2, F=4.16*, p<0.05). Oral propositional inferences correlated significantly positively with oral pragmatic inference (r=0.55* , p<0.02). But surprisingly propositional inferences in the oral and reading tasks were not correlated (r=0.14, n.s). This implies that within the same modality, here oral, there is a positive correlation between a lower and higher level of inference generation performance.

Research Question 4: Individual differences in learner responses in inference generation

An in-depth qualitative analysis of instances of the range of learner responses—from more to less accurate—was made to understand what gives rise to individual differences in inference generation.

The range of responses were analysed to look at the proportion of responses that do not converge with the answer key and how this can form material for teachers to provide constructive feedback. Note that this analysis is with respect to only the oral narrative comprehension task. Since, the print comprehension task had only propositional inference, such an analysis was not undertaken. The analysis of learner errors across the questions for propositional inference (Figure 3) and pragmatic inference (Figure 4) are presented.

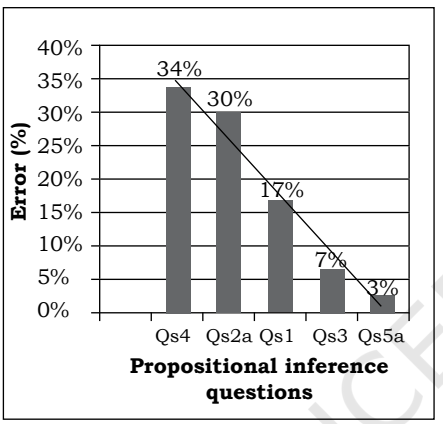


Figure 3: Propositional inference

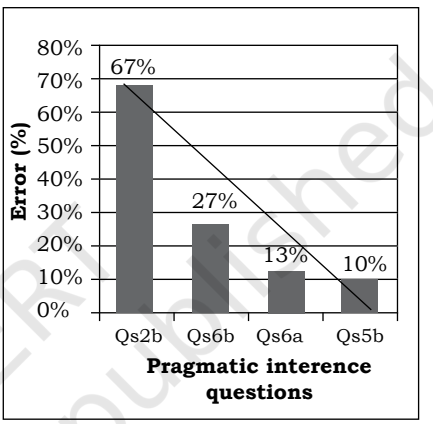


Figure 4: Pragmatic inference

The errors are presented as percentage frequency count in a decreasing order across the two inference categories. Note that learners are less accurate with more demanding inferences as indicated in Figure 4 in comparison to Figure 3 above.

Let us now look at some examples of actual learners responses from propositional and pragmatic questions in a qualitative manner to understand what gave rise to individual variations in narrative comprehension.

Qualitative Analysis of Propositional Inference Questions

Table 2 contains the frequency and range of answers for each propositional question divided into four categories—(i) correct (ii) partial situation knowledge, (iii) world knowledge and (iv) irrelevant or incorrect answers.

Table 2: Learner differences in propositional inference questions

Propositional Questions	Correct	Partial situation knowledge	World knowledge	Irrelevant
Q1: Why does the cat jump or leap forward? Ans: wants/to get/ catch/chase the butterfly/to play with the butterfly	25	On seeing the butterfly	It liked the butterfly	2
		On seeing the butterfly		
Q2a: How does the cat feel? Ans: Angry/ bad/ disappointed/ hurt	21	Will catch it again	It was hungry	1
		To catch the butterfly	It felt like eating the butterfly	
		I will catch the butterfly again	It felt like eating	
			It is tasty	
			To eat the butterfly	
Q3: Why does the boy hold the fishing rod in the water? Ans: Wants/ to get his ball back	28	0	0	2
Q4: Why does the cat grab the fish? Ans: Decided/wants to eat/have/steal the fish/takes the chance/ opportunity when the boy is not looking	20	It was hungry	Because the cat likes the fish	0
		It became greedy after seeing the fish	It likes the fish so much	
		It could not get the butterfly so started eating fish	It felt good to see the fish	
		It was hungry	Because cat was feeling good to see the fish	
		It was feeling sad	The felt good to see the fish	

Q5a: how does the boy feel? Ans: good/ fine/ happy/ please	29	0	0	1

Of the five questions, answers to two questions—2a and 4—have more instances of divergent answers. For instance, for Question 2a, 30 per cent of the learners were either not able to integrate reaction of the cat when it fails to catch the butterfly; they either expressed a partial situation model that the cat would try to catch the butterfly again or they used world knowledge of another episode where a cat can eat a fish and linked it to the butterfly and this is a faulty inference. For Question 4, the intension or goal of the cat is to be expressed. But 34 per cent of the learners were not able to build this inference that the cat in his mind decides to steal and eat the fish. They either gave the mental state of the cat being hungry or greedy, which is a partial situation model integration or they used world knowledge that cats like fish.

Qualitative Analysis of Pragmatic Inference Questions

Table 3 contains individual differences in answering the pragmatic questions presented in four categories as mentioned for propositional inference based responses in Table 2.

Table 3: Learner differences in pragmatic inference questions

Pragmatic Questions	Correct	Partial situation knowledge	World knowledge	Irrelevant
2b: Why do you think the cat is feeling angry/bad? Ans: Because cat could not catch the butterfly/fell into the bush/it hurts to fall into a pricky bush	10	The cat had thought of eating the butterfly	Because the butterfly was yellow in colour	6
		So that it can eat	Because there was a beautiful butterfly	
		How to eat it	Because the butterfly was very beautiful	
		Because cat was still hungry		

		The cat wants to eat		
		The cat wanted to catch the butterfly to eat		
		Because it will be very delicious to taste and eat		
		Became greedy by seeing the fish		
		Because there was a fish		
		Because the butterfly was sitting on the bush		
		So that the cat eat		
5b: Why do you think the boy is feeling good/happy? Ans: Because he has got the ball back	27	So that he can play again with that ball		1
		He used his fishing rod aptly.		
6a: How does the boy feel? Ans: Bad/angry/ mad	26 = angry: 20; bad: 5; shows displeasure:1		sad: 4	0
6b: Why do you think the boy feels bad/ angry/mad, etc.? Ans: Because the cat ate/ is eating/ took/ has taken his fish	22	Because he struggled hard	It is not good manners to eat others' things	
		Because he struggled to get the fish and wanted to eat		
		Because he struggled to get, but the cat enjoyed		

		The boy was catching the fish for a long time but could not eat it		
		Because he worked hard to catch fish and that cat came		
		Because he struggled hard to catch the fish		

To answer the pragmatic questions leaners needed to access and link world knowledge to the text or the episodes to complete the situation model. These questions were, therefore, more difficult to answer than the propositional inference ones. A question like 2b shows variation in inference generation at 47 per cent—there are responses listed in partial situational model where learners have related the causality of the cat's reaction to eating the fish, which is faulty. The fish is irrelevant in this episode. The cat is feeling bad because the butterfly escaped and the cat fell on the bush. Mentioning the fish or eating the butterfly basically shows that the child was unable to focus on the previous episode. The child already knew how the story ended so the child could not inhibit herself from making reference to a later episode of the story and focus only on the episode that the question was about. Some of the responses listed under world knowledge show that these learners have been able to only access how the butterfly looks like and fail to generate episode specific inference. Again in a question like 6b, learner variation in inference happens because they focus on the boy's failed attempts and not link the boy's reaction to the act of the cat (stealing and eating the fish). These are instances of building partial text model.

Feedback

Learner responses on the propositional and pragmatic inferences that show partial and world knowledge inferences can be taken up as partially correct answers. They can also serve as material for constructive feedback. Teachers can guide learners to generate more accurate inferences by helping learners 'notice' what is

missing or what needs to be selected. Thus, the proportions of learner responses on which feedback may be provided are listed in Table 4.

Table 4: Reassessment of Performance

	Percentage of correct responses	Percentage of responses that require feedback	Percentage of correct responses
Propositional Inference			
1	83%	11%	6%
2a	70%	27%	3%
3	94%	-	6%
4	67%	33%	-
5a	97%	-	3%
Pragmatic Inference			
2b	34%	47%	20%
5b	90%	7%	3%
6a	87%	13%	-
6b	73%	24%	3%

In Table 4 it can be seen that the learners' use of alternative forms of propositional inferences has led to a decrease in total percentage of incorrect responses for three questions and they are as follows— Qs4 (34% to 0%), Qs2a (from 30% to 3%), and Qs1 (from 17% to 6%). The error rate for pragmatic inference has decreased for the questions 2b (67% to 20%), 6a (13% to 0%) 6b (27% to 3%) and 5b (10% to 3%).

Discussion

A reassessment of learners' inference generation abilities was brought about on the basis of our analysis of the learners' ability to generate alternate responses as interim solutions before forming accurate inferences. Let us look at why some of the inferences are incomplete.

One reason for providing deviant answers is the inability to form a complete and appropriate episode wise situation model to answer questions like 1, 2a, 4 (propositional inference) and 2b and 6b (pragmatic inference). The learners have been able to create a partial representation of the model and therefore their answers are not fully accurate. If given feedback to notice the situation details

and complete their responses bridging world knowledge with the specific events in the narrative or providing additional information to complete the justification of the response, learners are likely to improve. We also observe that some of the deviant answers refer to later episodes in the story instead of the one the question is about (e.g., when the child responds to question 2b with reference to the cat noticing the fish which is a later part of the story). Given that the children have re-told the narrative, they are aware of the full story and seem to focus on the more recent developments rather than focus on the event asked about. This is also part of feedback that could be offered to the children that would enhance their ability to focus on details of the story as it unfolded and inhibit the more salient reference to the final episode where the story concludes.

A second reason for giving responses that do not match with the key are because the learners use world knowledge that is more generic in nature (e.g., cat liking the butterfly, or finding the fish tasty, etc.). Therefore answers to questions 1, 2a and 4 (pragmatic inference) and 2b and 6b (pragmatic inference) are based on learners' world knowledge. In such cases, learners need feedback to pay attention to combining the background or world knowledge they access with the situation specific or episode specific features to formulate answers that are coherent.

Figure 5 presents the answers that need feedback due to partial responses or world knowledge in contrast to the correct answers. The answers that need feedback are now separated from the incorrect responses. So we find that the percentage of errors has come down because 17 per cent of the responses can be improved based on the teacher feedback.

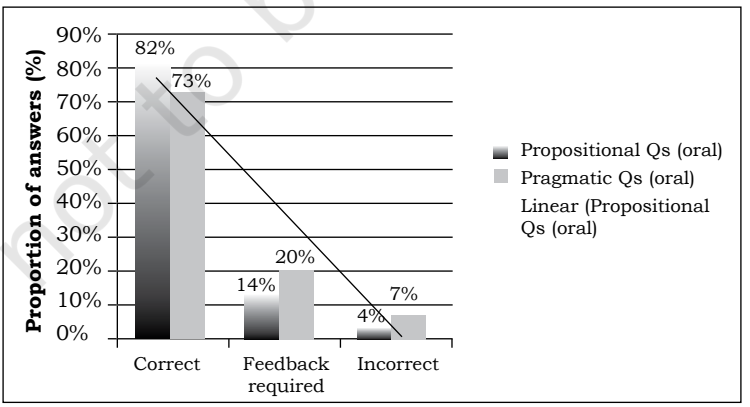


Figure 5: Differences of inference generation abilities

By comparing Figure 5 with Figures 3 and 4, it can now be concluded that a consideration of learners' partial situation model and/or world knowledge through which they access text comprehension clearly shows that their inference generation abilities are at work but at three levels:

correct < feedback required < incorrect

A study by Shepard-Carey (2019) shows a few methods in which emergent bilingual learner responses can be developed by way of scaffolding to arrive at appropriate text based and world knowledge based inferences. She uses pre-reading activities in small groups to help the learners predict the content to be read, focus on lexis to express inferences and activate background knowledge required to draw inferences for expository texts. Similar scaffolding methods can be adopted to give structured feedback once teachers are able to identify trends in responses. Without training to handle inference-based responses, teachers may look at divergent answers as instances of inference failure. The reason for them to do this would be that the variation in responses does not match with the key. Thus, variations in learner responses as we have presented through Tables 2 – 4, can be materials on which teachers can build constructive feedback and create learning opportunities.

In sum, the qualitative analysis of individual variations in this paper shows that of the total number of inappropriate responses to comprehension questions, many refer to experiential or world-knowledge inferences but fail to link them to the specific story-based information. This indicates difficulties with inference generation and the ability to select only the relevant parts of the response is what gives rise to individual variations in inference generation in young learners.

Conclusion: Pedagogical Implications of the Assessing Inference Generation Abilities

In this paper variations in responses of the learners have been analysed to demonstrate how comprehension development and feedback can be built into instructional practices of teachers. The kind of analysis of individual differences that this paper has reported is a novel approach to assess and develop comprehension skills and has not been attempted before. A narrative based comprehension task from the MAIN manual was used to find that the learners were able to tap into the mental states of the characters and were able to bring out inferences within the text (e.g., propositional inference),

new inferences that build up new events in the story (e.g., pragmatic inference) (Chikalanga 1992), interpret intentionality and make inferences about aspects of stories that support the creation of a situation model of comprehension (Perfetti and Stafura 2015).

Taken together, performance on both comprehension tasks seems to be good at an average of 77 per cent. This high performance on comprehension can be attributed to the high degree of overlap between the learners' home languages with the MoI (Hindi) at 90 per cent (refer to Table 1) (Tsimpli et al. 2020). It was also observed that 70 per cent of the learners who were successful in sentence and paragraph decoding ability also showed good comprehension skills in the print and oral.

The fact that oral propositional inference is the most successful type of inferential comprehension gives evidence that the process of comprehension is guided by the levels of difficulty of inferences (Cain et al. 2005) and the modality of comprehension. A reason for higher success in oral narrative comprehension could be because oral inference skills are found to develop earlier than print comprehension owing to one's variety of life experiences (Kendeau 2015); also the text had visual support, whereas in the print (ASER) test-t comprehension was more abstract as there was no visual support and it involved decoding skills. Thus, print modality added more challenge than oral modality.

A reason why oral propositional inference did not correlate highly with print propositional inference could be because absence of sentence level decoding skills in 30 per cent of the learners, which was an impediment to conscious attention towards reading comprehension. So, though this ability is found to be present in the learners in the oral modality and they are able to transfer it to the print modality, albeit not at a very high rate, given the fact that the print story was at a difficulty level appropriate for grade two learners.

Based on the findings in the qualitative analysis of individual differences in answering causal questions we can conclude that in comprehending a text better, a learner may be encouraged to create more fine-tuned situation models along with accessing their world knowledge. Teachers need to help learners focus on specific details of episodes and inhibit reference to final outcomes of the story. Teachers also need to gain awareness to treat learner differences in a constructive manner. These would create conditions for a gradual development of text-based as well as world knowledge-

based inferential skills in primary level of education in the Indian context (Swinney and Osterhout, 1990; Aukerman et al. 2017; Shepard-Carey 2019).

Conflicts of Interest: The authors declare no conflict of interest. The funding sponsors had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

References

Alcott, B. and P. Rose. 2017. Learning in India's primary schools: How do disparities widen across the grades? *International Journal of Educational Development*. 56. pp. 42–51.

Astington, J.W. and J.M. Jenkins. 1995. Theory of mind development and social understanding. *Cognition and Emotion*. 9. pp. 151–165.

Aukerman M, Schuldt L. and L. Aiello. et al. 2017. What meaning-making means among us: The intercomprehending of emergent bilinguals in small-group text discussions. *Harvard Educational Review.* 87(4). pp. 482–511.

Balasubramanian, A., M. Vogelzang., I. Tsimpli., M. Panda., S. Alladi., A. Reddy., L. Mukhopadhyay., J. Treffers-Daller. and Marinis, T. 2020. Reading Skills and Reading Comprehension in a Cohort of Multilingual Children from Disadvantaged Contexts in India. The First South Asian Forum on the Acquisition and Processing of Languages presentation: Germany.

Banerji, R. 2017. Language and Learning: The Challenges of Primary Education in India. In Coleman, H. (Ed). *Multilingualisms and Development: Selected Proceedings of the 11th Language and Develpoment Conference*. New Delhi. New Delhi: British Council.

Brinkmann, S. 2018. Teachers' Beliefs and Educational Reform in India: from 'learner-centred' to 'learning-centred' education. *Comparative Education*. 55(1). pp. 9–29. https://doi.org/10.1080/03050068.2018.1541661

Bruner, J.S. 1986. Actual Minds, Possible Worlds. Cambridge MA: Harvard University Press.

Chand, V. 2011. Elite Positionings Towards Hindi: Language Policies, Political Stances and Language Competence in India. *Journal of Sociolinguistics*. 15(1). pp. 6–35.

Chikalanga, I. 1992. A Suggested Taxonomy of Inferences for the Reading Teacher. *Reading in a Foreign Language*. 8. p. 697.

Clarke, P. 2001. *Teaching & Learning: The Culture of Pedagogy*. Sage Publications. New Delhi.

———. 2003. Culture and Classroom Reform: The Case of the District Primary Education Project, India. *Comparative Education*. 39(1). pp. 27–44.

Coté, N. and S. R. Goldman. 1999. Building Representations of Informational Text: Evidence from Children's Think-aloud Protocols. In H. van Oostendorp and S.R. Goldman (Eds.). *The Construction of Mental Representations During Reading.* pp. 169–193. Lawrence Erlbaum Associates Publishers.

Enver, J. 2018. Politics and Policy in Global Primary English. Oxford University Press. Oxford.

Gagarina, N., D. Klop., S. Kunnari., K. Tantele., T. Välimaa., I. Balciuniene and J. Walters. 2012. Multilingual Assessment Instrument for Narratives (MAIN). ZAS *papers in linguistics*. 56. pp. 1–140.

Graesser, A.C. and J. Roger. 2009. A Theory of Inference Generation During Text Comprehension. *Discourse process*. 16. pp. 145–160.

Jhingran, D. 2005. Language Disadvantage: *The Learning Challenge in Primary Education*. APH Publishing Corporation. New Delhi.

———. 2009. Hundreds of Home Languages in the Country and Many in Most Classrooms: Coping with Diversity in Primary Education in India. Social Justice through Multilingual Education. pp. 263–282.

Kendeou, P. 2015. A General Inference Skill. In: O'Brien EJ, Cook AE and Lorch RF (eds) Inferences During Reading. Cambridge, MA: Cambridge University Press. pp. 160–181.

Government of India. 1993. Learning without burden. Report of the National Advisory Committee. Ministry of Human Resource Development: Department of Education. New Delhi.

Lightfoot, A., A. Balasubramanian., I. Tsimpli., L. Mukhopadhyay and J. Treffers-Daller. (submitted). Measuring the Multilingual Reality: Lessons from Classrooms in Delhi and Hyderabad. *International Journal of Bilingual Education and Bilingualism.*

Long, D.L. and J.M. Golding. 1993. Superordinate Goal Inferences: Are they Automatically Generated during Comprehension? Discourse Processes. 16(1–2). pp. 55–73.

Matthew, R., A. Lightfoot., L. Mukhopadhyay and I. Tsimpli. (submitted). Multilingual Practices in Indian Classrooms: Pedagogical and Policy Implications for English Medium Contexts. In L. Adinolfi & U. Bhattacharya (eds.) Global Lessons from Multilingual Education in South Asia: At the Intersection of Policy and Practice. Routledge series in Language and Content Integrated Teaching & Plurilingual Education.

Meganathan, R. 2011. Language Policy in Education and the Role of English in India: From Library Language to Language of Empowerment. In Coleman, H (Ed). Dreams and Realities: Developing Countries and the English Language. London: British Council.

Miliand Winch, C. 2019. Teaching through Textbooks: Teachers as Practitioners of a Discipline? Theory and Research in Education. 17(2). pp. 181–201.

Mohanty, A. 2018. The Multilingual Reality: Living with Languages. Multilingual Matters.

MUKHOPADHYAY, L. 2020. Translanguaging in Primary Level ESL Classroom in India: An Exploratory Study. *International Journal of English Language Teaching*. 7(2).

NATIONAL COUNCIL OF EDUCATIONAL RESEARCH AND TRAINING. 2006. Position Paper of the National Focus Group on Teaching of English. New Delhi.

NATIONAL COUNCIL OF EDUCATIONAL RESEARCH AND TRAINING. 2005. NCF. New Delhi.

PERFETTI, C.A. AND J.Z. STAFURA. 2015. Comprehending Implicit Meanings in Text without Making Inferences.

PRATHAM. 2014. Annual Status of Education Report (Rural) 2013. New Delhi: Pratham. http://img.asercentre.org/docs/Publications/ASER%20Reports/ASER%202014/fullaser2014 ainreport_1.pdf

———. 2017. Annual Status of Education Report (Rural) 2016. New Delhi: Pratham.

SHEPARD-CAREY, L. 2019. The Inference-Making of Elementary Emergent Multilinguals: Access and Opportunities for Learning. *Journal of Early Childhood Literacy*. 0(0). pp. 1–39.

SMITH, F., F. HARDMAN. AND J. TOOLEY. 2005. Classroom Interaction in Private Schools Serving Low-income Families in Hyderabad, India. *International Education Journal*. 6(5). pp. 607–618.

SWINNEY, D.A. AND L. OSTERHOUT. 1990. Inference Generation during Auditory Language Comprehension. In Psychology of Learning and Motivation. Vol. 25. pp. 17–33. Academic Press.

TAYLOR, L. 2013. Testing Reading through Summary: Investigating Summary Completions Tasks for Assessing Reading Comprehension Ability. Studies in Language Testing, 39. Cambridge: UCLES/Cambridge University Press.

TSIMPLI, I., VOGELZANG, M., BALASUBRAMANIAN, A., MARINIS, T., ALLADI, S., REDDY, A. AND PANDA, M. 2020. Linguistic Diversity, Multilingualism and Cognitive Skills: A Study of Disadvantaged Children in India. Languages. 5(1).

TSIMPLI, I., L. MUKHOPADHYAY., J. TREFFERS-DALLER., S. ALLADI., T. MARINIS., M. PANDA., A. BALASUBRAMANIAN. AND SINHA, P. 2019. Multilingualism and Multiliteracy in Primary Education in India: A Discussion of Some Methodological Challenges of an Interdisciplinary Research Project. Research in Comparative and International Education. 14(1). pp. 54–76. doi:10.1177/1745499919828908

WESTBY, C.E. 2005. Assessing and Remediating Text Comprehension Problems. In Catts, H.W. and Kamhi, A.G. (eds) (2nd). Language and Reading Disabilities. Boston, MA; Pearson Education, Inc. pp. 157–232.

UNESCO. 2015. Education for All Global Monitoring Report: Achievements and Challenges.

Appendix 1

The Cat Story (MAIN Manual, pp. 111–117)

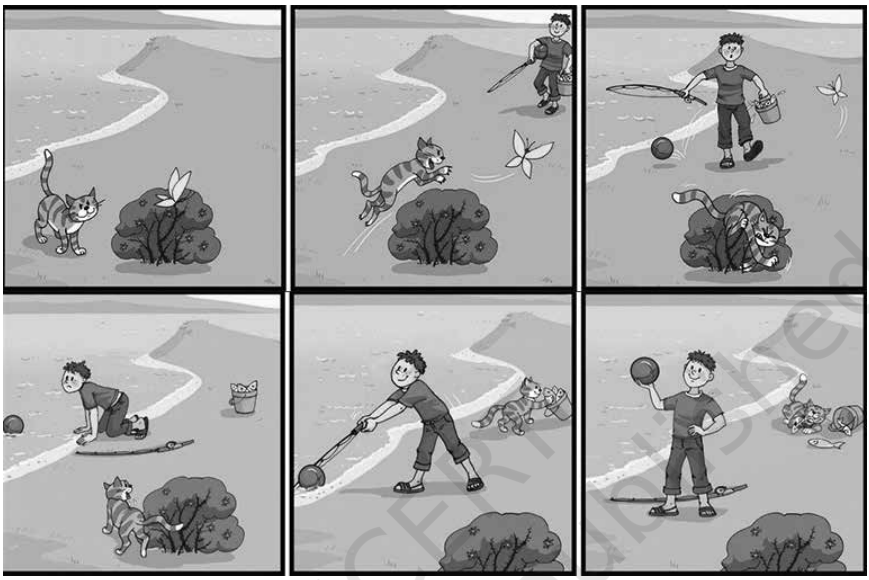


Table 5: Types of Inference Generation through Narrative Comprehension Questions

Episodes	NRT—Story Structure Elements	Comprehension Questions	Type of Inference
Episode 1	Goal— Cat (e.g., cat wanted to catch/get the butterfly)	Question 1 (Why does the cat jump/ leap forward?)	Propositional (Logical Explanatory)
	IST as Reaction (e.g., cat was angry/ bad)	Question 2a (How does the cat feel?)	Propositional → Pragmatic (Evaluative)
	Attempt (e.g., cat jumped forward/up)	Question 2b (Why do you think the cat is feeling angry/bad?)	Pragmatic (Evaluative)
Episode 2	Goal— Boy (e.g., boy wanted to get his ball back)	Question 3 (Why does the boy hold the fishing rod in the water?)	Propositional (Logical Explanatory)

	IST as reaction—Boy (e.g., boy was glad/ happy)	Question 5a (How does the boy feel?)	Propositional (Evaluative)
	Outcome— Boy (e.g., boy got his ball back)	Question 5b (causal) (Why do you think the boy is feeling good/happy?)	Pragmatic (Logical Explanatory)
Episode 3	Goal— Cat (e.g., cat wanted to eat the fish)	Question 4 (Why does the cat grab the fish?)	Propositional (Elaborative Explanatory - Causative)
Additional*	Extrapolative	Question 6 (perspective taking + causal) Imagine that the boy sees the cat 6a How does the boy feel? 6b Why do think the boy feels bad/angry/mad etc.?	Pragmatic (Evaluative) Pragmatic (Evaluative)

Profile Study of a School Going Child with Haemophilia

VINAY KUMAR SINGH*

ABSTRACT

The Rights of Persons with Disabilities Act, 2016 has specified 21 disabilities in its schedule where haemophilia has been added as one of the disability. Haemophilia is a bleeding disorder. A profile study of a school going child with haemophilia was conducted to identify the difficulties faced by the child in learning as well as carrying out day-to-day activities. A qualitative single case research design was adopted. Self designed research tools were administered to collect information. The findings revealed that there was very low or no awareness among stakeholders regarding haemophilia, its causes, symptoms, diagnosis, treatment and overall management. The child was facing lot of difficulties in learning due to his persistence absences from school and restricted participation in school activities because of his inconsistent episodes of internal or external bleeding, injuries and consecutive treatment. The school did not have any guidelines, specific educational intervention as well as individualised support programme for taking care of his health emergency, safety, education and coping with stress and pain. Teachers and parents, both, expressed their needs for training and support with regard to education and management of children with haemophilia

Keywords: *Haemophilia, disability, chronic health impairments, blood disorder, inclusive education.*

* *Professor*, Department of Education of Groups with Special Needs (DEGSN), NCERT, New Delhi-110016 (email: vinay.singh303@yahoo.com).

सार

दिव्यांगजन अधिकार अधिनियम, 2016 में विभिन्न 21 प्रकार की दिव्यांगता को निर्दिष्ट किया गया है जिनमें से हीमोफिलिया एक है। हीमोफिलिया एक अधिरक्तस्त्राव की अवस्था है। एक हीमोफिलिया से प्रभावित बच्चे के समक्ष दिन-प्रतिदिन की गतिविधियों को पूरा करने में आने वाली कठिनाइयों के साथ-साथ अधिगम संबंधी चुनौतियों का अन्वेषण करने हेतु यह पार्श्व-अध्ययन किया गया । इस अध्ययन में एकल व्यक्ति-विशेष गुणात्मक अनुसंधान विधि को अपनाया गया। सूचना एकत्र करने के लिए स्वनिर्मित अनुसंधान उपकरणों का प्रयोग किया गया। इस अध्ययन से यह ज्ञात हुआ कि हीमोफिलिया के कारणों, लक्षणों, रोग-निर्धारण, उपचार और समग्र प्रबंधन के बारे में अंतर्संबंधित लोगों के बीच बहुत कम या कोई जागरूकता नहीं थी। अपनी अंत: व बाह्य रक्तस्त्रावों, जख्मों और निरंतर उपचार प्रक्रिया की वजह से वह बच्चा विद्यालय से ज्यादातर अनुपस्थित रहता और कई गतिविधियों में उसकी भागीदारी वर्जित थी, जिसके कारण सीखने में उसे कई कठिनाइयों का सामना करना पड़ रहा था। विद्यालयों में हीमोफिलिया से प्रभावित बच्चों से संबंधित विशिष्ट शैक्षिक सेवाओं व व्यक्तिगत सहायता कार्यक्रम की रूपरेखा तैयार करने-जैसी कोई दिशानिर्देश नहीं थी, जो कि बच्चे की स्वास्थ्य-संबंधी आपातकाल की स्थिति में, उसकी सुरक्षा व शिक्षा हेतु तथा उसके मानसिक तनाव और शारीरिक पीड़ा से निपटारे में सहायक हो। शिक्षकों और माता-पिता, दोनों ने ही हीमोफिलिया वाले बच्चों की शिक्षा और प्रबंधन के संबंध में प्रशिक्षण और सहायता की आवश्यकता व्यक्त की।

Introduction

While playing football, cricket, bicycling and many other games, children do get easily injured. So scratches, cuts and bumps are regular part of a child's life and generally heal with little or no care. But what if it does not heal and bleeding from cuts does not stop, then it indicates a serious concern. Children with haemophilia cannot afford to get these everyday cuts and scratches.

India has enacted the Rights of Persons with Disabilities (RPwD) Act in 2016. This Act proclaims to ensure full and effective participation of children (persons) with disabilities and their inclusion in society without any discrimination and respect the rights of children with disabilities to preserve their identities. Inclusive Education is defined in this Act as a 'system of education wherein students with and without disabilities learn together and the system of teaching and learning is suitably adapted to meet the learning needs of different types of students with disabilities'. The RPwD Act, 2016 has specified 21 disabilities in its schedule where Haemophilia has been added as one of the disability under

the category 'disability caused due to chronic blood disorders'. Haemophilia is incurable, rare and genetic blood disorder in which blood does not clot normally and properly due to the lack or defectiveness of a specific Factor VIII, a clotting protein which helps in clotting after bleeding occur. When blood can't clot properly, excessive bleeding externally and internally occurs after any injury or damage. Incidence of 1 per 10,000 births progressing to chronic disability and premature mortality has been reported in studies. Indian haemophilia (bleeding disorder) registry has close to 20,000 haemophilia patients all over the country (Phadke, 2011; Ghosh and Shukla, 2017), though its estimated number swell near 50,000–100,000 (Kar, et al, 2014 and Ghosh and Shukla, 2017), when availability of investigative techniques, i.e., coagulation laboratories are available across 750 districts in the country (Ghosh and Shukla, 2017). Haemophilia can be mild, moderate and severe depending on the factor availability in the blood. Mild to severe complications include internal bleeding leading to swelling, risk of organ failure due to bleeding, easy bruising, targeted joints, damaging joints, numbness and pain of limbs, bleeding that does not stop after biting lip, nosebleed, tooth extraction, scratch and/ or paper cut. Having a disorder like this, affects the education of children while going through treatment and management of the disorder. High treatment cost of the disease leads to financial burden that also results in poor maintenance of regular treatment as well as child's physical inability to attend classes regularly in schools. These challenges directly or indirectly affect the education of children. So, the school life of children and their participation in school activities in school are also considered as an important yardstick for their quality of life. Keeping the complications of these children in view and the impact of the disorder on education of the child affected by the haemophilia, a study was conducted.

Objectives

1. To study the nature and severity of haemophilia in the child causing disability.
2. To identify the difficulties faced by the child with disability due to haemophilia in learning as well as carrying out day-to-day activities.

Research Method

Research Design

The design of this study was qualitative (single case design) in the nature.

Sample

A child with haemophilia studying in an elementary school of Dang District in the State of Gujarat, his parents, two teachers and a health care provider were interacted for in depth study to investigate the implications of haemophilia on learning and day to day functioning of the child and the family.

Research Tools

For collection of the information from primary sources, five research tools, i.e., Child Profile Sheet, Information schedule for Parents, Child and Health Care Providers and a Questionnaire for Teachers were designed. Child Profile Sheet was used to obtain information about the child with haemophilia. It consisted of nine sections for obtaining detailed information on socio-demographic clinical profile of the child. This profile sheet was used in collecting disease related specific information, present complications, previous consultations, record of investigations, childhood history, nature of physical illness, immunisation history, daily routine of the child, school history, play profile, familial composition and family history of this disease, social and neighbourhood ecology, specific management problems faced by the parents and parental report of the child. Interview Schedule for Parents was used to collect information regarding the child's health, education and overall management of the disorder. This interview schedule had 29 items with 10 open ended items restricted to record responses in maximum four to five sentences and 19 yes/no type items with space to query reasons for 'yes/no' responses. Interview Schedule for Child was also used to collect information from the child regarding his own health, education and his engagement in day to day activities. This interview schedule had 15 items with nine open ended items restricted to record responses in maximum four to five sentences and six yes/no type items exploring specific reasons for 'yes/no' responses. Interview Schedule for Health Care Providers was used to collect information from the treating doctor regarding

the child's health, his illness, treatment and overall management of the disorder. This interview schedule had 18 items with eight open ended items restricted to record responses in maximum four to five sentences and ten yes/no type items having spaces to enquire reasons for 'yes/no' responses. Questionnaire for teachers was used to collect information regarding the child's education and his participation in school activities. This questionnaire had 19 items with eight open ended items restricted to record responses in maximum four to five sentences and eleven yes/no type items having spaces to enquire reasons for 'yes/no' responses. The items and questions of all the tools were distributed unevenly across the tool in order to minimise the mental set and carry over effects. These research tools were reviewed jointly by a team of registered medical practitioners, trained in treatment of haemophilia and other blood disorders, licensed rehabilitation practitioners, trained in education and rehabilitation of children with disability and group of educationists, sociologists and psychologists, who had more than twenty years of experiences in their respective field. The items or questions appeared ambiguous or in which there was poor agreement among the different reviewers were reworded or replaced with more suitable items or questions. Content validity for the questionnaire was further established through detailed discussion with medical practitioners, rehabilitation professionals, social workers, teachers and clinical counsellors.

Profile Study of Participant

An eleven years old normal appearing pleasant hemophilic male child belonging to tribal rural lower socio-economic class, studying in Class VI in an elementary school of Dang District in the State of Gujarat in India was selected for this study. His previous history revealed that during infancy, once he fell down from bed and had a bump on his forehead. Local doctor made a cut on it for blood flow and bleeding stopped normally at that time. He was first diagnosed with haemophilia at the age of four years after a bleeding episode in which bleeding did not stop consecutively for eight days after a minor cut by a blade on the right side of nose. At that time, he was taken to local doctors who were not aware of disorder. Later he was taken to Civil Hospital which is around 150 km away from his home and doctor diagnosed him with Haemophilia A, Factor VIII deficient. His family members were already aware of some of the symptoms of haemophilia disorder as child's cousins were suffering

from the same disease and leading a manageable life. The child had one elder brother who had not shown any signs and symptoms of haemophilia and never underwent any test to rule out haemophilia too. Maternal grandfather also had Haemophilia. Child's mother and aunt were sisters and married in the same family to younger and elder brother respectively, both were carrier of the disorder as established in a medical report. Since, the child's father was aware of some of the symptoms already, hence while admitting the child in the present school, father explained headmaster and other teachers about the disorder and ask them to take extra care of this child. He requested his teachers not to bother much if he did not do well in studies. As per father's verbatim, 'teachers used to take care of child like a fragile glass'. He previously got admission in Eklavya Model Residential Schools (EMRS) after passing the state level examination for admission in Class VI of EMRS. He was staying in the hostel of EMRS but as he regularly required Factor VIII four times in a month, he had to withdraw himself from the school and hostel. He was a bright, intelligent and curious student and used to ask a lot of questions while in class as reported by his teachers and father, though he was facing various challenges in his day-to-day life. He used to remain absent from classes for around 12–15 days in a month to attend medical interventions for his disorder during which he always missed out most of the parts of his syllabus, resulting lower achievement than the expected level. He showed poor academic achievements almost in all subjects, as reported. Parents were worried about his learning, academic achievements and his future since he was a bright child otherwise. There were no special provisions or plans prepared either by the school or by the teachers to cover up his missed out syllabus. He was dependent on his classmates' class-notes only. He could not sit for long periods of time in the class. His wrist and elbow joints used to get frozen while writing continuously and sometimes bulged up. He could not afford to miss his examination due to risk of failure. He was always fearful of being retained in same class for the next year in case he would fail, or his school would be changed as happened earlier. During examination, whether he had pain or in the need of Factor VIII of the blood, he used to appear in his examination and never tried to escape from attempting to write examination paper because of his illness. After finishing his examination paper, he used to leave for hospital to receive Factor VIII infusion, if required. He also abstained from playing sports due to the fear of getting a

bleeding episode. Even a little pat on his shoulder by friends while playing used to develop swelling in those areas and ended up with requirement of Factor VIII infusion. He did not participate in most of the school activities as his classmates. His school was around 1.5 km away from his home and he had to walk down to reach the school. He could not carry his own school bag on his shoulders since due to weight of the bag he could develop swelling and it sometimes, became an emergency case for immediate Factor VIII infusion. He could not stand for long period of time (more than half an hour) constantly. He could not walk continuously and travel for a long distance otherwise swelling usually appears in his both feet. His favourite hobby was cycling but due to this disorder, he used to avoid cycling. Swelling was present around his ankle joints of the left leg during case work up and limping while walking was also observed. He could not consume mid-day-meal within the limited time period, since he was facing difficulty in chewing and swallowing the food items due to affected jaws because of the disorder.

Teachers of the present school were not aware about the disorder and did not know about emergency remedies if required, though father had explained to child's teachers, headmaster and classmates during admission. Teachers expressed their need for training on education and management of children with haemophilia in schools and other similar disorders. Frequency of bleeding episodes occurs 2–3 times in a month; 500 mL quantity of Factor VIII was required through infusion, but generally 250 mL remained available at the hospital (as reported) due to the shortage or unavailability of factor. Every time parents had to make request to avail 500 mL of Factor VIII. Child had to travel for more than 4 hours in a public bus to get factor injected or sometimes ended up getting no infusion due to unavailability of Factor VIII in the hospital. He and his family were found struggling for availing Factor VIII, spending money, time and energy again and again. Sometimes he used to get irritated and angry due to his disorder and became obstinate during pain episodes. While in severe pain, the child used to cry a lot, scream and start crawling on the floor. Now he started developing self coping mechanism to live with the disease. He tried to avoid taking risk of any physical injury on his own. He used to share his feeling of stress with his peers. His classmates started visiting his home in the evening hour almost daily. They used to play simple and easy indoor games together and also share the activities of the class

with the child and his parents. Parents were assisting the child in learning activities at home as his classmate started sharing the class-notes and activities. Parents, after intervention of School Management Committee and resource teacher, were maintaining regular contact with his teachers for ensuring his participation in classroom activities. They tried to collect his homework during his period of absentees to cover up the missed out syllabus. However, due to poor financial condition, parents were found struggling with their daily hassles of livelihood. Family could not afford specific food suggested by the doctor. Commutation expenses and visit to doctor did cost them 4–5 thousands monthly, for meeting these expenditure father had to take financial help from acquaintance due to his low economic status. Father was not satisfied with the treatment due to the unavailability of factor remained in spite of his and family effort for requesting the medical fraternity in the hospital.

Discussion

World Health Organisation considers disability, not just a health problem, but it is a complex phenomenon, reflecting the interaction between features of a person's body and features of the society in which he or she lives. People with disabilities may face difficulties while interacting with persons, objects or activities in his immediate environment. It requires interventions to remove these environmental and social barriers. For a long time children with disabilities were studying in secluded schools and then in separate classes after movements towards integrate them in regular schools. After enforcement of the Right of Children to Free and Compulsory Education Act, 2009 in India, education became fundamental right of every student including children with disability in inclusive setup as endorsed in the Rights of Persons with Disabilities Act 2016. Haemophilia is one of the disabilities caused due to chronic blood disorders. Haemophilia is rare and inherited bleeding disorder where blood does not clot normally after internal or external bleeding usually affecting only male but transmitted by women to their male children. Although the genetic basis of this disorder has been well studied in India, data on the number of individuals, trends of the disorder in India, have not been properly reported. Available data and studies are mainly from the field of medical science related to treatment procedures. Very limited studies are available in literature

on challenges faced by these children from socio-psychological and educational perspectives. There is very low or no awareness among the health care providers, parents, teachers and community at large regarding haemophilia, its causes, symptoms, diagnosis, treatment and overall management. Referring to this study family was not aware of the causes of haemophilia that it is inherited; mother could be the carrier of the disorder, which could have been pretested or prescreened before birth of the child while having two other persons in the family already suffering from haemophilia. Females are rarely severely affected or suffer the symptoms. They are the carrier of the disorder. Ghosh and Shukla (2017) quoted in their study not to forget carrier mothers, sisters and daughters and occasional female sufferers of this disease. The manifested child and the family were found suffering and struggling for Factor VIII due to its unavailability in the hospital as quoted in earlier study as 'high cost low volume disease' (Ghosh et al., 2008). Human body have 13 clotting factors which help in clotting blood and having defective or lack of Factor VIII and IX, causes haemophilia. There are mainly two types of haemophilia, Haemophilia A where Factor VIII is deficient and Haemophilia B where Factor IX is deficient. General indication is bleeding, which is often spontaneous into joints and soft tissues (Barr et al., 2002). Children are more prone to bleeding due to movement oriented activities.

Availability of medical product is a one of the major problem in many countries (Shapiro et al., 2001). In this case too, it was found that the lack of resources, even in the metro city like Mumbai, seem to be an important cause of mismanagement in health, causing adverse impact on education and the whole life of the affected child as reported in many studies. From educational point of view, managing education of haemophilic child seems challenging. The effect of haemophilia on the educational aspect has also been interest of researchers. Haemophilia can result in a wide range of physical, social, and academic activities among school-aged children (Shapiro et al., 2001). Here in this case the child lost his residential school facility due to his bleeding disorder. His previous residential school as well as the present government school did not have any specific guideline for taking care of such children's health, safety and security. He had to change his school from residential set up of EMRS to general government school due to this blood disorder.

Thies (1999) had reported that around 58 per cent of school children with chronic conditions routinely remain absent from school and 10 per cent miss more than 25 per cent of the year. This child was also unable to attend the classes regularly due to bleeding episodes and consecutive treatment protocols supporting the findings of earlier studies too, highlighting higher rates of absenteeism in school children suffering from hemophilia than others (Markova and McDonald, 1980; Woolf et al., 1989; Colgrove et al., 1994) and inconsistencies between student's ability and academic achievement as they progress through higher classes (Olch D., 1971). A Multicenter Hemophilia Growth and Development Study (HGDS) report provided insight on interconnection between long-term hospitalisation and poor achievement test scores in reading as well as spelling, resulting lower achievement than the expected level based on IQ (Loveland et al., 1994) of the child. Most of the times in spite of being in school, this child missed out a number of school activities to participate, especially physical (e.g., movement) in nature restricting his opportunities to learn by different modes and means supporting the findings of Irwin and Elam, 2011 that chronically ill children can experience various multiple issues associated to their illness that interfere with school activities. Children with hemophilia may be generalised to other chronic health impairments and associated conditions to some extent, contributing to school absenteeism, interfering with physical function, and the child's ability to take part in regular tasks of childhood (Shapiro et al., 2001).

It was reported that teachers did not have any individualised support programme as recommended in the RPwD Act, 2016; as seen in the report of Department of Education, Government of UK that there was no specific programme of educational intervention existed in schools for such children with persistent absences (DoE, 2019). Persistent absence from schools by children with chronic disease could certainly interfere with children's educational and social development as reported in earlier studies also (Weitzman M, 1986). Children with such chronic health impairments could have remarkable impact on the academic performance due to waxes and wanes in attendance, lack of ability to engage in standardised measures, and poor performance on assessments due to low school participation. The child and family did not get any educational support from teachers and schools. The child used to feel isolated causing low self esteem and low level of confidence. This study has

raised an important interconnection between the number of bleeding episodes experienced and scholastic achievement in a school-aged child with severe hemophilia as found in earlier study (Shapiro et al., 2001). Moreover, the high treatment cost of the disease leads to financial burden that also results in poor maintenance of regular treatment as well as child's physical inability to attend classes regularly in schools. Subsidised treatment services were of limited availability causing significant out of pocket expenditure for parents affecting quality of life of the child and the whole family.

Conclusion and Recommendations

Disability is a form of social diversity. Society, therefore, has responsibility to educate and take care of children with disabilities. Every child with or without disability has the right to get equal educational opportunities to achieve his or her academic potential. Haemophilia is a chronic blood disorder causing disability, where cure is not attainable due to limited resources. There are limited systematic epidemiological data on Haemophilia. Treatment is prolonged, unpleasant and repetitive. The treatment processes affect a child's physical and mental health, education and life satisfaction. Today's researchers are more concern about the child's education and quality of life and are trying to improve their life standards by different medical as well as educational intervention options. There is an urgent need to develop specific guidelines for school on educational intervention and individualised support programme for these children with chronic health impairments. Sensitisation of teachers on haemophilia is utmost important. Capacity building of the in-service teachers through nationwide programme is also the need of the hour. This is also required to revisit the pre-service teacher education programmes both in the area of general teacher education programme regulated by National Council of Teacher Education as well as in special teacher education programme regulated by the Rehabilitation Council of India. Beside these, community awareness programme may also be organised at local level so that the community would be aware of the needs and strengths of the affected child and mobilise resources (may be through E-village, medical home, etc.) to the family. The health care system may introduce digital platform to notify the availability of the resources and factors, particularly in such type of cases. Today, it becomes essential for educationists and rehabilitation professional to develop educational assessment measures to

determine the learning and other needs of these children so that an appropriate educational intervention programmes can be developed in order to prepare them to confront independently with each and every situation appear their life.

References

Barr, R., M. Saleh., W. Furlong., J. Horsman., J. Sek., M. Pai and I. Walker. 2002. Health Status and Health-related Quality of Life associated with Hemophilia. *American Journal of Hematology*. Vol. 71. pp. 152–60. https://doi.org/10.1002/ajh.10191.

Colgrove R.W. And R.M. Huntzinger. 1994. Academic, Behavioural and Social Adaptation of Boys with Hemophilia/HIV Disease. *Journal of Pediatric Psychology*. Vol. 19. pp. 457–473.

Department of Education. 2019. Pupil Absence in Schools in England: 2017 to 2018.

Available online at:

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/787463/Absence_3term_201718_Text.pdf accessed on 20.03.2020.

Ghosh, K. and K. Ghosh. 2016. Management of Haemophilia in Developing Countries: Challenges and Options. *Indian Journal of Hematology and Blood Transfusion*. Vol. 32. No. 3. pp. 347–355.

———., S. Shetty and K. Ghosh. 2008. Haemophilia: A High Cost Low Volume Disease: Suitable Preventive Strategies for Developing and Developed Countries. Open Hematology Journal. Vol. 2. pp. 20–24. doi: 10.2174/1874276900802010020.

———. and R. Shukla. 2017. Future of Haemophilia Research in India. Indian Journal of Hematology and Blood Transfusion. DOI 10.1007/s12288-017-0872-2.

https://www.rarebleedingdisorders.com/content/dam/medical/rarebleedingdisorders/resources/documents/transitions/Dads_in_Action_Hemophilia_and_School_Success.pdf accessed on 20.03.2020

https://www.who.int/topics/disabilities/en/ accessed on 21.04.2020

Irwin, M.K. and M. Elam. 2011. Are We Leaving Children with Chronic Illness Behind? Physical Disabilities.Education and Related Services. Vol. 30. No. 2. pp. 67–80.

Kar, A., S. Phadnis, S. Dharmarajan and J. Nakade. 2014. Epidemiology and Social Costs of Haemophilia in India. *Indian Journal of Medical Research*. Vol. 140. No. 1. pp. 19–31.

Loveland, K.A., J. Stehbens., C. Contant., J.D. Bordeaux., P. Sirois., T.S. Bell., S. Hill., A. Scott., M. Bowman., M. Schiller., J. Watkins., R. Olson., P. Moylan., V. Cool. and B. Belden. 1994. Hemophilia Growth and Development Study: Baseline Neurodevelopmental Findings. Journal of Pediatric Psychology. Vol. 19. pp. 223–239. https://doi.org/10.1093/jpepsy/19.2.223

Markova, I. and K. Mc Donald. 1980. Integration of Hemophilic Boys into Normal Schools. Child: Care, Health and Development. Vol. 6. pp. 101–109.

Olch D. 1971, online 2012. Effects of Hemophilia upon Intellectual Growth and Academic Achievement. *Journal of Genetic Psychology.* Vol. 119. pp. 63–74. https://doi.org/10.1080/00221325.1971.10532627

Phadke, S. 2011. Haemophilia Care in India: A Review and Experience from a Tertiary Care Centre in Uttar Pradesh. *Indian Journal of Hematology Blood Transfusion.* Vol. 27. No. 3. pp. 121–126. doi: 10.1007/s12288-011-0084-0.

The Rights of Persons with Disabilities Act. 2016. Ministry of Social Justice and Empowerment, Government of India. New Delhi.

The Right of Children to Free and Compulsory Education Act. 2009. Ministry of Human Resource Development, Government of India, New Delhi.

Shapiro, A.D., S.M. Donfield, H.S. Lynn, V.A. Cool, J.A. Stehbens, S.L. Hunsberger, S. Tonetta and E.D. Gomperts 2001. Defining the Impact of Hemophilia: The Academic Achievement in Children with Hemophilia Study. Pediatrics. Vol. 108, No. 6. e105. doi: 10.1542/peds.108.6.e105.

Shetty, S. and K. Ghosh. 2012. Cancers in Patients with Haemophilia: A Retrospective Study from the Italian Association of Haemophilia Centers: A Rebuttal. *Journal of Thrombosis and Haemostasis*. Vol. 10, No. 6. pp. 1200–1201.

———, N. Sharma and K. Ghosh. 2016. Epidemiology of Hepatocellular Carcinoma (HCC) in Haemophilia.Critical Reviews in Oncology/ Hematology. Vol. 99. pp. 129–133.

———, T. Shelar, D. Mirgal, V. Nawadkar, P. Pinto, S. Shabhag, A. Mukaddam, B. and K. Ghosh. 2014. *Rare Coagulation Factor Deficiencies: A Countrywide Screening Data from India. Haemophilia.* Vol. 20, No. 4. pp. 575–581.

Thies, K.M. 1999. Identifying the Educational Implications of Children with Chronic Illness in School Children. *Journal of School Health.* Vol. 69, No. 10. pp. 392–397.

Weitzman, M. 1986. School Absence Rates as Outcome Measures in Studies of Children with Chronic Illness. *Journal of Chronic Disease.* Vol. 39. pp. 799–808.

Woolf, A., L. Rappaport, P. Reardon, J. Cibrorowski, E. D'angelo and J. Besette. 1989. School Functioning and Disease Severity in Boys with Hemophilia. *Journal of Developmental Behavioural Pediatrics.* Vol. 10, No. 2. pp. 81–85.

Construction and Validation of an Aptitude Test for Pre-service Teachers on Inclusive Education

H.S. MISTRY*

ABSTRACT

This paper describes the development and validation of a measure of pre-service teachers' teaching aptitude towards inclusive education of students with disabilities. Five factors, namely— knowledge about inclusive education, perceived ability to identify disabilities, attitude towards teaching children with disabilities, perceived ability to adapt inclusive teaching methods and skills to manage the inclusive classroom were tested. Fifty items were constructed under the listed five factors and the test was implemented on 552 pre-service teachers of Gujarat state. The test was found to be a reliable and valid tool for measuring pre-service teachers' teaching aptitude towards inclusive education.

सार

यह लेख दिव्यांग छात्रों के समावेशी शिक्षा के प्रति सेवापूर्व अध्यापकों के शिक्षण अभिक्षमता के एक माप के विकास और विधिमान्यकरण का वर्णन करता है। पांच कारकों, अर्थात समावेशी शिक्षा के बारे में ज्ञान, अशक्तताओं की पहचान करने की कथित योग्यता, दिव्यांग बच्चों को पढ़ाने के प्रति अभिवृत्ति, समावेशी शिक्षण विधियों को अनुकूलित करने की कथित योग्यता और समावेशी कक्षा के प्रबंधन के लिए कौशलों, का परीक्षण किया गया। सूचीबद्ध पांच कारकों के अंतर्गत 50 एकांशों का निर्माण किया गया था और परीक्षण को गुजरात राज्य के 552 सेवापूर्व शिक्षकों को दिया गया था। परीक्षण को सेवापूर्व अध्यापकों के समावेशी शिक्षा के प्रति शिक्षण अभिक्षमता को मापने के लिए एक विश्वसनीय और वैध उपकरण पाया गया।

* *ICSSR Post-Doctoral Fellow*, Department of Education [CASE, IASE & IUCTE], Faculty of Education and Psychology, The Maharaja Sayajirao University of Baroda, Vadodara-390002 (e-mail: mistryhemendra2015@gmail.com)

Introduction

Inclusive Education has been started to break the isolation between special and general education, to bridge the gap between them and to mainstream Children with Disabilities (CwD) into general education to learn with their peers. But despite policies and provisions, inclusive education has not achieved desired success due to lack of supporting system (Shevde, 1997), lack of awareness about policies and provisions among general educators (Zaveri, 2001), negative attitude towards CwD (Philips, 2007) and attention of teachers towards CwD in classroom (Nayak, 2008). These may be the reason for exclusive system of education and unreachable goal of Education for All.

Many academics in the field of inclusive education consider teacher education is essential for the implementation of inclusive education in the classroom (Ainscow, 2005; Booth et al, 2003; Sandhill and Singh, 2005). In recent time, the general teacher education diplomas and degree courses available nation wide do include an optional 'special education' paper to train and prepare teachers to identify and assess disability. However, it was not an integral part of the training and it does not train teachers to deal with the challenge, diversity and negative attitudes (Singhal, 2005). This resulted in distrust in both the special and mainstream education systems which led some parents to keep their CwD at home for the fear of their abuse or neglect in the classroom (Zulka, 2005). Since, the National Council of Teacher Education (a statutory body of Government of India) Regulation (2014), inclusive education is an integral part of the second year curriculum of the two-year B.Ed. course. Many surveys have found that teachers' attitude towards inclusion is not particularly positive (Ellins and Porter, 2005) and they expressed concern about their lack of preparation for inclusion and for teaching all learners (Forlin, 2001). Thus, there is a need to make changes in the selection of teachers who can be helpful for the inclusive education programme. The persons with high inclusive education teaching aptitude should be spotted out through proper testing and advised to join inclusive school after providing the training. Thus, admitting candidates with aptitude for inclusion can benefit in making the inclusive education successful.

Human working efficiency is not easily measured as it varies across a number of factors such as aptitude for task involved, adequacy of training for the task, motivation and condition of work, etc. Aptitude is a quality in an individual which is indicative

of the probable extent to which a person will tend to acquire under suitable training. If a person has an aptitude for teaching that means she or he has capacity to acquire proficiency in teaching under appropriate conditions and will succeed in teaching. Many factors are involved with teaching aptitude like knowledge, communication skills, academic achievement and personality traits (Kaur, 2007).

When we say a person possesses an aptitude for teaching in an inclusive set-up, it is assumed that she or he has a good proportion of the traits required for becoming successful as an inclusive education teacher. The magnitude of these traits may differ from person to person or even the number of traits possessed by each person may also differ. A number of traits required for being successful teacher in inclusive education compose as a whole the aptitude for teaching in inclusive education. Thus, the high or low aptitude for teaching in inclusive education is in proportion to the number of traits possessed by an individual. It also depends on the nature of the traits possessed.

Thus, estimating the aptitude for teaching in inclusive setting requires assessing it through a proper test. By constructing the present inclusive education teaching aptitude test, an attempt is made to satisfy a felt need of such test. Unlike other tests constructed so far meant for general teaching aptitude, the aptitude test for pre-service teachers on inclusive education is specifically prepared to measure aptitude for teaching in inclusive education and termed as Inclusive Education Teaching Aptitude Test (IETAT).

Existing Teaching Aptitude Instruments in India

The number of published instruments to measure teaching aptitude is less and all of them are meant for measuring general teaching aptitude. In 1961, Shah developed aptitude test for secondary school teachers. This test has five dimensions, attitude towards children, mental ability, interest in profession, adaptability and professional information. The reliability and validity of the test was estimated to be 0.80 and 0.533, respectively. Based on the line of Shah's test, Singh and Sharma (1998) developed another teaching aptitude test battery with the same five dimensions. The test consisting 120 items and was standardised on 1,090 pupil teachers of primary teachers' training institutions. The test constructed by the Pandey (1970) measures professional knowledge, vocabulary, inferential, reasoning, number series, numerical reasoning, logical, general information and reading comprehension and was tested on

1,190 secondary school teacher trainees. Teaching aptitude test by Prakash and Srivastava (1973) has 10 sub-sets viz. cooperative attitude, kindliness, patience, wide interest, fairness, moral character, discipline, optimism, scholarly taste, and enthusiasm. The test provides 150 Likert type items for secondary pre-service teachers to respond on a five point scale. The reliability of the test was found 0.891 (split-half method) and 0.91 (Guttman and Spearman-Brown Prophecy formula) and quite satisfactory validity (0.5).

The teaching aptitude test battery by Karim and Dixit (1986) aims to measure teaching aptitude of high school teachers in eight areas — cooperative nature, consideration, wide interest and scholarly taste, fair mindedness and impartiality, moral character and discipline, optimistic attitude, motivational aspect and dynamic personality. The test provides 80 items and the respondents need to respond on a 3 point scale. The reliability of the test was estimated by applying split-half method (0.85) and Guttman and Spearman Brown's prophesy formula (0.91). Gakhar and Rajnish in 2004 developed teaching aptitude test which has shown good validity (0.68), internal consistency and test-retest reliability (0.74). This four point Likert type instrument measures six dimensions of teaching aptitude, namely— teaching profession, interest towards students, social contexts, innovations regarding activate standard, professional ethics and teaching potentialities. Based on the test result, the teachers can be classified as right, good and dedicated teachers.

The teaching aptitude instruments developed so far are meant for measuring general teaching aptitude only. So, a test to particularly measure teaching aptitude towards inclusive education is required.

Method

Construct of IETAT

Based on the review of the standardised general teaching aptitude tests developed in past and available materials on teaching in inclusive classroom, a list of traits to be covered under IETAT was prepared. For arriving at a convenient and workable list of traits that might be regarded as proofs of possessing the teaching aptitude for inclusive education by a pre-service teacher, a rating scale was prepared. The prepared list was sent to 16 subject experts (SEs) in

the field of teacher education, inclusive education and psychology of education for their rating on the importance of traits for being a teacher in inclusive school. The experts were requested to rate the traits on five-point scale and also suggest trait(s) that can be included under the IETAT. Some of the inter-related and similar traits were merged and the following five factors were identified.

1. Knowledge about Inclusive Education
2. Perceived Ability to Identify Disabilities
3. Attitude towards Teaching CwD
4. Perceived Ability to Adapt Inclusive Teaching Methods
5. Skills to Manage Inclusive Classroom

Participants

Data from 552 pre-service teachers of first year B.Ed. course from the 13 Teacher Education Institutions of the Gujarat state, India, were collected and used to standardise the IETAT. Most of the participant pre-service teachers were females (n=480) and younger falling the age group of 21 to 25 years (n=500). More than half of the respondents were from urban area (n=302) with postgraduate qualification (n=278) and from arts (n=298) field. A vast majority of the pre-service teachers neither had any previous contact with the persons with disabilities (n=522) nor had any previous teaching experience (n=464).

IETAT Development

Item Writing

The objective type (stem followed by four alternatives) items were written related to above mentioned five factors. Equal numbers of items (10 items) were framed under each factor comprising a total of 50 items with difficulty values between 93.4 and 13.4 and validity indices ranges between 0.26 and 0.82.

Scoring

The pre-service teachers were required to encircle to the alternative selected as correct. One mark was assigned to every correct answer and no mark assigned to the wrong answer (maximum score ranging between 0–50). The highest score obtained in the test was '35' while the lowest score was '7'. Thus, the IETAT yields seven separate score ranges viz. above 35 (very high), 30–34 (high),

25–29 (above average), 20–24 (average), 15–19 (below average), 10–14 (poor) and below 10 (very poor).

Item Analysis

Item analysis was done using the content validity method suggested by Lawshe (1975). Content Validity Ratio (CVR) for each item was calculated. Items with high CVR were included in the test. Also, items with internal consistency index were found out and all the items were re-arranged as per their difficulty value (D).

Results

Items with high CVR ranging from 0.25 to 1 and those items with internal consistency index (r) 0.20 or more were selected in the final version of the test. Item wise CVR, difficulty value and internal consistency index (r) of final IETAT are given in Table 1. The range of the difficulty values of the items selected was between 93.4 and 13.4. Items in each section were re-arranged as per their difficulty value (D) so that the easiest items were on the top and hardest items at the bottom. The final test consists of 50 items (Annexure-1).

Validity

The items were included in the test on the basis of CVR and internal consistency index so the test has content and construct validity in relation to the teaching aptitude towards inclusive education. Criterion related validity of the test was found out by correlating the scores of IETAT with the examination scores of the pre-service teachers in the subject of Creating Inclusive School in a sample of 110 pre-service teachers. The validity coefficient was found to be 0.52.

Table 1

CVR, Difficulty Value (D) and Internal Consistency Index (r) of the Items Selected in the Final Version of IETAT

Section	Item No.	CVR	D	r
Section I (Knowledge about inclusive education)	1	0.88	86.7	0.51
	2	0.25	73.4	0.34
	3	0.5	73.4	0.70
	4	0.38	68.4	0.42
	5	0.63	61.7	0.26
	6	0.5	56.9	0.53

	7	0.63	46.7	0.29
	8	0.75	33.4	0.61
	9	0.25	33.4	0.61
	10	0.75	20	0.42
Section II (Perceived ability to identify disabilities)	11	0.88	61.7	0.28
	12	0.25	61.7	0.25
	13	0.38	60	0.54
	14	0.75	53.4	0.62
	15	0.5	46.7	0.53
	16	0.75	46.7	0.53
	17	0.88	40	0.40
	18	1	20	0.42
	19	0.63	20	0.42
	20	0.25	13.3	0.29
Section III (Attitude towards teaching children with the special needs)	21	0.88	86.7	0.50
	22	0.75	86.7	0.54
	23	0.5	73.4	0.32
	24	0.5	60	0.82
	25	0.75	40	0.38
	26	0.88	40	0.71
	27	1	40	0.38
	28	0.63	13.4	0.29
	29	0.88	13.4	0.29
	30	0.5	13.4	0.29
Section IV (Perceived ability to adapt inclusive teaching methods)	31	0.88	73.4	0.32
	32	1	60	0.80
	33	0.63	53.3	0.41
	34	0.5	53.4	0.60
	35	1	40	0.38
	36	0.63	33.4	0.33
	37	0.75	26.7	0.51
	38	0.38	26.7	0.51
	39	0.63	20	0.42
	40	0.63	13.4	0.29

Section V	41	0.5	93.4	0.38
(Skills to manage the inclusive classroom)	42	1	73.4	0.31
	43	0.38	66.7	0.45
	44	0.88	60	0.29
	45	0.25	40	0.69
	46	0.88	33.4	0.29
	47	0.25	33.3	0.29
	48	0.63	20	0.42
	49	0.63	20	0.42
	50	0.5	13.4	0.29

Reliability

The reliability of the test was established by the application of 'split-half' method (0.97), K-R formula (0.65) and Hoyt's method (0.62). Thus, the reliability of the IETAT can be fixed at 0.75. Index of validity and index of reliability indicate that the IETAT has validity and reliability for measuring the pre-service teachers' teaching aptitude towards inclusive education.

Table 2

Mean, Median, Mode and SD of the Scores in IETAT

N	Mean	Median	Mode	SD
552	20.57	20.55	20.51	5.45

Table 2 shows that there is not much difference between the mean, median and mode. Hence, the distribution is normal and the selected sample is representative of the population.

Conclusion

The present research was conducted to develop and validate a test to measure pre-service teachers' teaching aptitude towards inclusive education. The result from item analysis and estimation of validity and reliability indicates that the present IETAT is capable to measure pre-service teachers' teaching aptitude towards inclusive education. The description of the scores obtained by the pre-service teachers is normal and it suggests that a majority of the pre-service teachers coming under the average group do possess

some kind of aptitude for teaching in an inclusive setting. The test may also helpful to stakeholders involved in admission at pre-service teacher training courses in general teacher education.

References

Ainscow, M. 2005. From Special Education to Effective Schools for All. Key Note Presentation at The Inclusive and Supportive Education Congress 2005. University of Strathelyde, Glasgow.

Booth, T., K. Nes and M. Stromstad. 2003. Developing Inclusive Teacher Education: Drawing the Book Together. In T. Booth, K. Nes, and M. Stromstad (Eds., 2003), *Developing Inclusive Teacher Education.* RoutlegeFalmer. London.

Ellins, J. and J. Porter. 2005. Departmental Differences in Attitudes to Special Educational Needs in the Secondary School. *British Journal of Special Education.* 32(4). pp. 188–195.

Forlin, C. 2001. Inclusion: Identifying Potential Stressors for Regular Class Teachers. *Journal of Educational Research.* 43 (3). pp. 235–245.

Gakhar. S.C. and Rajnish. 2004. *Manual for Teaching Aptitude Test.* RakhiPrakashan. Agra.

Prakash, J. and R.P. Srivastava. 1973. *Manual for The Teaching Aptitude Test.* The Psycho-Centre, New Delhi.

Kaur, D. 2007. Academic Achievement, Teaching Aptitude and the Personality Traits as the Predictors of Success in Elementary Teacher Training. Unpublished Ph.D. Thesis (Education). Jamila Milia Islamia, New Delhi.

Lawshe, C.H. 1975. A Quantitative Approach to Content Validity. Personal Psychology, 28, pp. 563–575. Retrieved on March 20, 2020 from https://pdfs.semanticscholar.org/cd20/d9ae1554a2665983798a6f14a8f9a7272223.pdf

Nayak, J. 2008. *Attitude of Parents and Teachers Towards Inclusive Education.* EDUTRACKS. 7 (6). pp. 18–20.

Pandey, K.P. 1970. *Construction and Standardisation of a Teaching Aptitude Test.* Ph.D. Thesis (Education). Jiwaji University, Gwalior, Madhya Pradesh. In Fifth Survey of Research in Education, NCERT. New Delhi.

Philips, M. 2007. The Lived Experience of General Educators and Inclusion Teachers. In Dissertation Abstract International. Vol. 68, No. 1.

Sandhill, A. and Singh, A. 2005. Inclusion: Some Emerging Directions in the Indian Context. Paper presented at the Inclusive and Supportive Education congress 2005, University of Strathelyde, Glasgow.

Karim, S. and A.K. Dixit. 1986. *Manual for Teaching Aptitude Test Battery.* Rupa Psychological Centre. Agra.

Shah, M.M. 1961. An Aptitude Test for Secondary Teachers: Construction and Standardisation. Unpublished Ph.D. Thesis (Education). The Maharaja Sayajirao University of Baroda. Vadodara.

SHEVDE, S. 1997. Feasibility Study of Models of Inclusive Education. Unpublished M.Ed. dissertation, Centre of Special Education, SNDT Women's University, Mumbai. In NCERT (2001), Sixth Survey of Educational Research (1993–2000). New Delhi.

SINGH, R.P. AND S.N. SHARMA. 1998. Teaching Aptitude Test Battery. National Psychological Corporation. Agra.

SINGHAL, N. 2005. *Responding to Difference: Policies to Support 'Inclusive Education' in India.* Paper presented at the Inclusive and Supportive Education congress 2005, University of Strathelyde, Glasgow.

ZAVERI, L. 2001. *Development of an Awareness Module on Inclusive Education for Students with Disabilities for Administrators and Teachers of General Schools.* Unpublished M.Ed. dissertation, Centre of Special Education, SNDT Women's University, Mumbai. In NCERT (2001), Sixth Survey of Educational Research (1993–2000). New Delhi, NCERT.

ANNEXURE-1

Aptitude Test for Pre-service Teachers on the Inclusive Education

Dear Friend,

This Inclusive Education Teaching Aptitude Test (IETAT) is constructed for measuring your teaching aptitude for inclusive education. Fifty items related to your thought about the Inclusive Education are given in this booklet. Four alternatives are given with every item. Read every item carefully and give your answer by encircling the option ◯ in the given separate answer sheet.

For example, suppose your answer is 'a' then encircle on the 'a' option, i.e., (a)

Please read these instructions carefully before giving answers.

Instructions

- Provide all the general information about your age, gender, stream, level of education, teaching experience by encircling the appropriate alternative given with every item.
- There are 50 items given under five factors viz., Knowledge about Inclusive Education (10 items), Perceived Ability to Identify Disabilities (10 items), Attitude towards Teaching Children with Disabilities (CwD, 10 items), Perceived Ability to Adapt Inclusive Teaching Methods (10 items) and Skills to Manage Inclusive Classroom (10 items).
- Do not leave any item unanswered.
- There is no time limit for completion of this test. But work rapidly as much as you can.
- The main purpose of this test is to measure your aptitude only. There are no marks for this test and this test will not affect your result or academics.
- Besides answering write difficulties (if any) in answering and your suggestions or opinions for further improvement of item(s).
- Research studies are useful only when reliable and accurate data are collected. So, please give honest and sincere answers.
- Return the answer sheet along with the test-booklet to test administrator after answering all the items.

You are assured that all the information provided by you will be kept strictly confidential and used for the research purpose only.

Thanking you,

Dr. H. S. Mistry

Abbreviations Used

- CwD Children with Disabilities
- EMR Educable Mentally Retarded
- CwOI Children with Orthopaedic Impairment
- CwVI Children with Visual Impairment
- CwHI Children with Hearing Impairment
- CwMR Children with Mental Retardation
- CwD Children with Disabilities

General Information			
Name of the College/Institute: _____			
Name of the University: _____			
Age:	a. 21 to 25 years	b. 26 to 30 years	c. More than 30 years
Gender:	a. Male	b. Female	c. Third Gender
Habitat:	a. Urban	b. Rural	
Caste Category a. General b. Other Backward Class (OBC) c. Scheduled Castes (SC) d. Scheduled Tribes (ST)			
Stream:	a. Arts	b. Science	c. Commerce d. Other (please specify) .....
Educational Qualification			
a. B.A.	e. M.A.	i. M.Phil.	
b. B.Com.	f. M.Com	j. Ph.D.	
c. B.Sc.	g. M.Sc.	k. Other _____	
d. Other _____	h. Other _____		
Teaching Experience:	a. Yes	b. No	
• If yes, year of experience:			
a. Less than 1 year	c. 3 to 5 years		
b. 1 to 2 years	d. More than 5 years		

- Type of school
  a. Government c. Private Un-Aided
  b. Private Un-Aided

Experience in Teaching Children with Disabilities (CwD): a. Yes b. No

- If yes, type of disability
  a. Hearing impairment
  b. Mental retardation
  c. Orthopaedic impairment
  d. Visual impairment
  e. Other (mention) _____

Item No.	Section I Knowledge about Inclusive Education
1.	In inclusive education, teacher needs to recognise students'
	a. individual differences b. physical differences c. mental differences d. age differences
2.	As an inclusive school teacher, you need to have strong skill in conducting
	a. action research b. historical research c. correlation research d. descriptive research
3.	As a new teacher in inclusive school, you will not
	a. participate in academic forums on inclusive education b. work collaboratively with other teachers c. participate with experienced teachers d. criticise other teachers work
4.	Inclusive education programme does not focus
	a. inclusion of all types of children in school b. providing adequate infrastructure facilities to CwD c. accommodation of CwD into a general school setting d. the restructuring of schools to accept and provide for the needs of CwD
5.	The ultimate goal of inclusive education is to teach
	a. all students together b. minority students

	c. slow learners d. CwD
6.	Inclusive education does not mean a. including all CwD in the special schools b. determining the placement of CwD in general classroom c. creating an environment that supports and include all types learners d. providing the home based education to all CwD
7.	Enrolling CwD in general schools can a. affect the quality of education b. lead to less enrolment of other students c. affect the performance of other students d. realise their potentials as other students
8.	Inclusive education involves a. grouping the CwD with their disabled counterparts b. providing the home based education to all CwD c. keeping the CwD in segregated classrooms d. keeping the CwD in general classrooms
9.	Learning in inclusive classroom should not be a. active b. passive c. in group d. participatory
10.	As an inclusive classroom teacher, which opportunity will you prefer most to give to parents of CwD? a. To collaborate in decision making about the placement, information and services of their child. b. To share the information about the achievement of their child. c. To take care in completing the home assignments of their child. d. To participate in the school functions.
Item No.	**Section II** **Item No. Perceived Ability to Identify Disabilities**
11.	Observe the given figures carefully.  I II III IV

	Select the correct alternative that depicts the types of disability. a. I—Blindness, II—Deafness, III—Orthopaedic handicap, IV—Mental retardation b. I—Deafness, II—Orthopaedic handicap, III—Mental retardation, IV—Blindness c. I—Mental retardation, II—Blindness, III—Deafness, IV—Orthopaedic handicap d. I—Orthopaedic handicap, II—Mental retardation, III—Deafness, IV— Blindness
12.	The teachers will not show remarkable readiness to enroll and teach the CwD unless they are a. highly qualified b. aware of disabilities c. kind and sympathetic d. interested in social service
13.	Which among the following is not the feature of Rights of Person with Disabilities Act (2016)? a. Mental Health of the CwD b. Full participation of the CwD c. Equal opportunity to the CwD d. Protection of rights of the CwD
14.	Which among the following represents the functional relationship of the terms? a. Impairment → Disability → Handicap b. Handicap → Disability → Impairment c. Disability → Impairment → Handicap d. Impairment → Handicap → Disability
15.	One of your students who cannot see properly because of faulty image formation is an example of a. impairment b. retardation c. disability d. handicap
16.	Mental retardation is not a a. disease b. disability c. condition d. impairment

17. IQ range of the Educable Mentally Retarded (EMR) is

a. 1–19
b. 20–39
c. 40–54
d. 55–70

18. Suppose one of your student is having trouble in hearing and understanding soft speech in noisy background. Which among the following hearing loss he will have?

a. Moderate hearing loss
b. Profound hearing loss
c. Severe hearing loss
d. Mild hearing loss

19. Children with Orthopaedic Impairment (CwOI) should not be over protected in class because

a. it may develop the habit of demanding extra attention
b. it may develop the habit of demanding extra materials
c. it may develop the habit of demanding more learning
d. it may develop the habit of demanding leave

20. Match the column A with column B.

	Column A (Type of Disability)		**Column B (Supporting Device)**
A	Children with Visual Impairment (CwVI)	I	Visual and tactile aids for learning
B	Children with Orthopaedic Impairment (CwOI)	II	Sign language
C	Children with Hearing Impairment (CwHI)	III	Calipers
D	Children with Mental Retardation (CwMR)	IV	Abacus for mathematics learning

a. A–I, B–II, C–III, D–IV
b. A–II, B–III, C–IV, D–I
c. A–IV, B–III, C–II, D–I
d. A–III, B–IV, C–I, D–II

Item No.	Section III Attitude towards the Teaching Children with Special Needs
21.	Quality of life of CwD in their adulthood cannot be improved unless they are provided educational support at the stage of a. higher education b. primary schooling c. secondary schooling d. higher secondary schooling
22.	Suppose a visually impaired student studying in Class VII is residing in your neighbouring area. And parents request you to teach her after your college hours. What will be your response? a. I will advise them to recruit special teacher for their child b. I will accept as it will help me to gain some experience c. I will tell them about my busy schedule d. I will reject their request as it's not my duty
23.	After your training at the B.Ed. level, you get a job in an inclusive school where CwD are enrolled. You will a. accept the job as teaching all types of students is teacher's duty b. reject job by thinking that it's burden to teach CwD c. not join job and will start private coaching d. search job in other schools
24.	Which among the following categories of students will you prefer to teach in your classroom? a. Gifted b. CwD c. All students including CwD d. Socially and economically weak
25.	Respect and support to CwD cannot be best taught to non-disabled students of classroom unless teacher a. tells stories on disability b. orders normal students c. show videos on disability d. models the same
26.	Given an opportunity to teach in inclusive class, you will not remain much focused on students' a. understanding b. weaknesses c. strength d. interest

27.	Excellent educational infrastructure, articulated educational policy, well resourced programme and effective inclusion must not take place without a. meaningful instruction delivery by the teachers b. good administration of school principal c. cooperation of community members d. expertise of supporting staff
28.	According to you, which factor is not contributing to the achievement of CwD in inclusive school? a. Class size b. Quality of teacher c. Class background d. Supporting services
29.	Engaging CwD in co-curricular activities is most important because a. they can learn some activities. b. they can receive entertainment. c. their social skills can be improved. d. their academic burden can be lessened.
30.	Now-a-days, various disability specific softwares are available but suppose the school where you are working has not installed that software yet. As an inclusive school teacher, you will a. request the concerned authority to procure such software. b. blame school principal for not making the software available. c. wait till the software is installed. d. not bother as it is not your duty.
Item No.	**Section IV** **Perceived Ability to Adapt Inclusive Teaching Methods**
31.	For successful application of assistive technologies for the CwD, which among the following parameter will you not take care? a. Knowledge of CwD about technology b. Types of technological innovations available c. Ways that empower the CwD for mainstream life d. Potential of CwD for the better use of that technology
32.	Suppose you have 30 children alongwith 3 CwDs (1CwVI, 1CwOI and 1CwHI) in your classroom and you are assigning a task by dividing the entire class into three groups (10 children in a group) viz Group A, B and C. Which of the following groups will you create to make your classroom inclusive?

	a. A (7 Non-disabled children + 3 CwD), B (10 Non-disabled children), C (10 Non-disabled children) b. A (10 Non-disabled children), B (8 Non-disabled children + 1 CwD (CwOI), C (9 Non-disabled children + 2 CwD (CwVI&CwHI) c. A (10 Non-disabled children), B (8 Non-disabled children + 2 CwD (CwOI&CwVI), C (9 Non-disabled children + 1 CwHI) d. A (9 Non-disabled children + 1 CwOI), B (9 Non-disabled children + 1 CwVI), C (9 Non-disabled children + 1 CwHI)
33.	The plus curriculum is generally recommended for children with a. blindness b. mental retardation c. hearing impairment d. orthopaedically handicap
34.	Total communication method could be best suitable in teaching students with a. mental retardation b. visual impairment c. hearing impairment d. orthopaedic impairment
35.	Which among the following, will you not consider for adjusting curriculum to suit theCwD? a. Interest towards learning b. Learning aptitude c. Learning needs d. Ability to learn
36.	In inclusive education, individualised instruction does not mean a. individual instructions as and when required for teaching-learning b. individual teaching to CwD as per their learning need c. permitting child to pursue a preferred mode of learning d. teaching by individual teacher
37.	Which among the following aspects you will not consider for evaluating success of CwD in inclusive education? a. Academic achievement b. Attitude towards learning c. Interaction with teachers and peers d. Inability to participate in some co-curricular activities
38.	For teaching a blind or a low vision student in inclusive classroom, there must be no change in

	a. Content of lesson b. Curricular activities c. Instructional method d. Strategies of teaching
39.	For learning to meet the diverse needs of all students, which among the following design will you use? a. Programmed design of learning b. Universal design of learning c. National design of learning d. State design of learning
40.	Which among the following, will you not consider for adjusting curriculum to suit the CwD? a. Interest towards learning b. Learning aptitude c. Learning needs d. Ability to learn
Item No.	**Section V** **Skills to Manage Inclusive Classroom**
41.	You as a teacher will not attach label 'disabled' to the Children with Disability (CwD) because labelling has adverse effects on their a. social aspect b. language aspect c. economical aspect d. philosophical aspect
42.	Why does a teacher require adequate training in classroom management practices for inclusive education? a. To meet the requirements of inclusive practices for students with special needs. b. To manage and administer the behaviour of CwD. c. To discipline the CwD. d. To handle the CwD.
43.	Arrange the following categories in order that teacher must have for professional development in inclusive education. I Basic knowledge of the characteristics of CwD and understanding of their role and responsibility in the inclusive education process. II Understanding how to differentiate instructions to meet the needs of CwD. III Effective classroom management strategies to promote academic engagement and pro-social behaviour while minimising disruptions to the learning environment.

	IV Learning strategies to communicate and collaborate effectively with resource teachers or special educators. a. I, II, III, IV b. IV, III, II, I c. III, II, IV, I d. II, III, I, IV
44.	Suppose you are working as a full time teacher in general school and two CwD are enrolled in your class. You will provide the work in small group because A. all students including CwD can be more active B. all students including CwD can be more involved C. all students including CwD can form their group D. all students including CwD can be supportive to each other a. A, B and C b. A, B and D c. A and B only d. B and D only
45.	For effective classroom management in inclusive education, a teacher does not require proficiency in the analysis of students' a. outcomes b. behaviour c. performance d. mental condition
46.	As an inclusive school teacher, which among the following strategies will you use to promote friendship among your students? a. Ordering students to make friendship b. Selecting activities that involve competition c. Creating rituals that involve some students of the class d. Selecting activities that involve cooperation and collaboration
47.	Suppose your school is not yielding satisfactory result for inclusive education, which among the following issue will you not address for improving the result in inclusive education? a. Need of curriculum Modifications b. Lack of infrastructural Facilities c. Lack of playing Equipments d. Lack of educational Materials
48.	Which among the following will not be helpful to an inclusive school teacher for identifying and assessing the CwD?

	a. Observing them in various settings b. Administering paper-pencil tests c. Administering psychological tests d. Examining school records
49.	Which of the following types of seating arrangement will you use for the CwD in your classroom so that each one of them can be easily observed by you? a. S b. T c. U d. Z
50.	Which among the following competencies is least important for the regular school teachers in inclusive classroom? a. Interaction with CwD b. Teaching PLUS curriculum c. Managing behaviour of CwD d. Creating learning environment

Ethno-mathematics

Mathematics Embedded in the Traditional Activities of Kumhar Community of the Varanasi District

HARISH PANDEY* AND ANJALI BAJPAI**

ABSTRACT

Various cultural groups have their specific ways of acquiring the useable functional mathematics. They unconsciously apply mathematical skills in their everyday life without realising its significance. Position Paper of National Focus Group on Teaching of Mathematics, NCERT, New Delhi, states that in Indian villages, it is commonly seen that people who are not formally educated use many modes of mental mathematics. These practices of mathematics at local level may be treated as indigenous, oral (vedic), hidden (frozen), and folk mathematics. These different concepts are a part of ethno-mathematics and provide a right of practice to every individual. This paper looks at mathematics used by Kumhar (also known as Prajapati) community, involved in their traditional activities like pot making, carving and selling in different areas of Varanasi district of Uttar Pradesh state. This paper will discuss the steps involved, things used and pattern followed in different types of practices used in pot making and the mathematics embedded in it like the concepts of angle, geometry, mensuration, symmetry, sequencing, Operations Research, reasoning, spiral, conic section, etc. An interview schedule having questions from five areas— biographic information, traditional activities, logic used and Culture, inventory control, and marketing is used and an observation was made for each practices in a naturalistic setting to gather the evidences. Results have implications for teaching of mathematics in a cultural context.

Keywords: *Ethno-mathematics, kumhar community, vedic and frozen mathematics.*

सार

विभिन्न सांस्कृतिक समूहों के पास प्रयोज्य कार्यात्मक गणित प्राप्त करने के अपने विशिष्ट तरीके हैं। वे अनजाने में गणितीय कौशलों का अपने दैनंदिन जीवन में उपयोग करते हैं।

* *Senior Research Fellow*, Faculty of Education(k), Banaras Hindu University, Varanasi, India

** *Professor,* Faculty of Education(k), Banaras Hindu University, Varanasi, India anjali68bajpai@gmail.com

एनसीईआरटी, नई दिल्ली के नेशनल फोकस ग्रुप के टीचिंग ऑफ मैथेमेटिक्स के ऊपर पोजिशन पेपर में कहा गया है कि भारतीय गांवों में आमतौर पर देखा जाता है कि औपचारिक रूप से शिक्षित नहीं होते हुए भी गणित का उपयोग कई तरीकों से करते हैं। स्थानीय स्तर पर गणित की इन प्रथाओं को स्वदेशी, मौखिक (वैदिक), अप्रत्यक्ष (अवरूद्ध) और लोक गणित के रूप में माना जा सकता है। ये विभिन्न अवधारणाएं एथनो-गणित का एक भाग हैं और प्रत्येक व्यक्ति को अभ्यास का अधिकार प्रदान करती हैं। यह लेख कुम्हार (जिसे प्रजापति के नाम से भी जाना जाता है) द्वारा प्रयुक्त गणित के अध्ययन पर आधारित है, जो उत्तर प्रदेश राज्य के वाराणसी जिले के विभिन्न क्षेत्रों में मिट्टी के बर्तन बनाने, नक्काशी और बेचने जैसी अपनी पारंपरिक गतिविधियों में पारंगत हैं। इस लेख में मिट्टी के बर्तन बनाने में प्रयुक्त विभिन्न प्रकार के अभ्यासों में शामिल चरणों, उपयोग की गई चीजों और पैटर्न तथा इसमें सन्निहित गणितीय संप्रत्यय जैसे कि कोण, ज्यामिति, मैन्सुरेशन, समरूपता, अनुक्रमण, संक्रियात्मक अनुसंधान, तर्क, सर्पिल, शांकव खंड आदि की अवधारणाओं पर चर्चा की गई है। अध्ययन में एक पंच भागीय साक्षात्कार अनुसूची; जीवन-संबंधी जानकारी, पारंपरिक गतिविधियाँ, प्रयुक्त तर्क और संस्कृति, माल नियंत्रण, और विपणन का उपयोग किया गया। साथ ही सूचनाओं को इकट्ठा करने के लिए एवं प्राकृतिक सेटिंग में क्रियाकलापों के अध्ययन के लिए एक अवलोकन अनुसूची का प्रयोग किया गया। परिणामों का निहितार्थ एक सांस्कृतिक संदर्भ में निहित जानकारी का गणित शिक्षण में उपयोग पर बल देता है।

Introduction

The word ethno-mathematics has two parts 'ethno' and 'mathematics'—To understand its etymological meaning we can consider these words separately and then together. The word 'mathematics' comes from Greek term '*mathema*' which means knowledge, study, learning, science and arts. The Greek prefix 'ethnos' stands for a group of people living together. This can be explained as something belonging to a particular social group or ethnic group. This is only etymological description of ethno-mathematics, practically the word ethno refers to the specific working process to solve the problem and the second term refers to the logical terms and conditions used to arrive at the result of the problem.

The Brazilian Educator and Mathematician Ubiratan D'Ambrosio introduced the word ethno-mathematics to the world in 1977, after launching his ethno-mathematicalprogram as a methodology to track and analyse the processes of generation, transmission, diffusion and institutionalisation of mathematical knowledge in diverse cultural systems or groups (D'Ambrosio, 1985, 1990, 2001). While using the word for the first time D'Ambrosio

(1985) expressed that 'the term requires a dynamic interpretation because it describes concepts that are themselves neither rigid nor singular namely, ethno and mathematics'. The term ethno describes, 'all of the ingredients that make up the cultural identity of a group— language, codes, values, jargon, beliefs, food and dress, habits, and physical traits.' Mathematics expresses a 'broad view of mathematics which includes ciphering, arithmetic, classifying, ordering, inferring, and modeling'. In contrast to 'academic mathematics', i.e., the mathematics which is taught, practiced and learned in schools and universities, D'Ambrosio called it ethno-mathematics. He expressed that so many children fail in mathematics due to, "the mechanism of schooling that replaces these practices by other equivalent practices which have acquired the status of mathematics, and have been expropriated in their original forms and returned in a codified version".

D'Ambrosio, while giving its first definition stated, "Ethno-mathematics is the mathematics which is practiced among identifiable cultural groups such as tribe societies, labour groups, children of certain age brackets and professional classes". Ethno-mathematics explores the diverse expressions of mathematical ideas. Now-a-days it also involves the deliberations on issues related to society and culture and their impact on teaching and learning. The consonance of Ethno-mathematics and mathematics education goes to explore the fact that mathematics learning is a cultural and social process.

Apart from the above ethno-mathematics may also be introduced as part of cultural and traditional practices. 'Ethno-mathematics can be understood as the region of intersection between cultural anthropology and academic mathematics that utilised mathematical

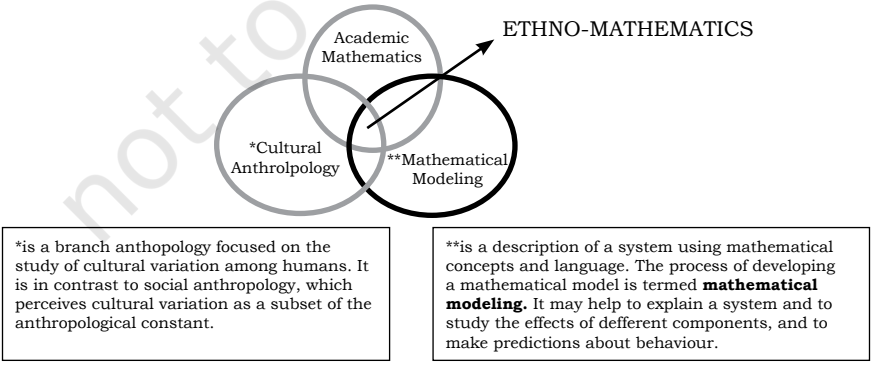


Figure 1 : Concept of the Ethno-mathematics

modeling to solve the problem taken from reality' (D'Ambrosio, 1990 and Rosa, 2010, cited in, Abiam *et.al.* 2016). Figure 1 depicts it clearly.

In India, few researches have been done in this area though our country contains high level of social-cultural diversity and mathematical practices. Some eminent scholars and institutions are working in this area. Information Technology (IT) Education department of International Institute of Information Technology (IIIT) Hyderabad, India has developed a tool to teach fractions; based on ethno-mathematics principle. Gupta (2009) used many riddles from stories and instances to solve the reasoning problems in mathematics.

Background of the Study

The study is based on the investigator's doctoral work on the topic *'Ethno-mathematics: An Investigation of an Approach for Teaching Learning Mathematics (TLM) from the Traditional Activities of the Kumhar Community of Varanasi District'*. The study was conducted on Kumhars classified as Other Backward Community (OBC), in Varanasi district of Uttar Pradesh. An economically middle class and politically active community, women also play a significant role in family (Kotte and Surendra, 2016). In their Anthropological Study, Kotte and Surendra (2016) introduced many other names of Kumhar like Prajapati, Kummar, Machavaram, Mannepalli, Pathipati, Kulluru, Chejerla, Kondapati, Chirivella and Yadavalli in relation to different cultural and linguistic profile.

Ascher (1991) stated in his study that people are unconsciously applying mathematical skills in everyday life without realising its importance. There is a great probability that such skills, if incorporated in teaching learning practices in schools could advance the outcomes of learning mathematics. The main reason behind taught mathematics at schools is to sharpen real life practices such as counting, ordering, sorting, measuring, weighing, etc. Therefore, the skills of those applying mathematics in their cultures, without any formalised training, could contribute positively towards improving performance by the learners in the classroom (Bishop, 1988; Gerdes, 1996; Zaslavsky, 1975).

Mogege (1999) investigated the relationships between cultural games and the teaching and learning of mathematics. The main aim of his work was to look at various cultural and traditional games that are found in different cultural settings, with a view towards

making use of these games in the mathematics classroom. Likewise, Gerdes (2000) noted that one of the principles of good teaching is to give importance of understanding the cultural background of the pupils and relating the teaching and learning process to it. He enlisted some non-academic aspects of academic mathematics, like socio, informal, folk, hidden, and oral mathematics. Bishop (2002), observed that every classroom now a days is characterised by the ethnical, linguistic, gender, social and cultural diversity. Teachers should have to deal with the existing cultural diversity since mathematics is defined as human and cultural knowledge deeply in comparison to any other field of knowledge. Significant effect of ethno-mathematics approach on students achievement and interest in geometry and mensuration has been reported (Kurumeh, 2004; Abiam *et al.*, 2016). Both the studies were carried out in Nigeria and approaches were developed from cultural experiences and observations. Kurumeh developed the approach from the culture of Nasukka area of Nigeria and suggested the useful aspects of Indigenous Mathematics to the curriculum planner, policy makers and administrators of the Nigeria. Abiam *et al.* (2016) recommended that ethno-mathematics based instructional approach should be adopted in the teaching of geometry. Hara-Gaes (2005) investigated the mathematics embedded in the cultural activities of the Damara people in the Khorixas areas of Namibia in real setting. He traced out many mathematical concepts from the traditional activities, house construction, sewing place and others. He also investigated the concepts of measuring, triangles, breadth, length, equality and counting from their activities.

The Indian curriculum reforms (i.e., *National Curriculum Framework, 2005*) also suggested the need for developing the ability for mathematisation in the child. The Position Paper of the National Focus Group on Teaching of Mathematics (2006, p. 11) indicates many problems regarding teaching-learning of mathematics, such as students fear and failure, phobia, boring classroom setting, disappointing curriculum, traditional ways of teaching mathematics, etc., and further provided many recommendations to solve these hurdles. One of the recommendations was to enable children to the relate mathematics to people's lives. Position paper states that in Indian villages, it is commonly seen that people who are not formally educated use many modes of mental mathematics, it may also be called folk algorithms. The study was conducted on the Kumhar community who use lots of mathematical concepts in their work.

Description of Keywords

Ethno-mathematics: Ethno-mathematics is the study of mathematics as embedded in the cultural and traditional activities of the Kumhar community of Varanasi district.

Kumhar and Kumhar Community: Kumhar belongs to the Hindu religion, caste wise they belong to Other Backward Class (OBC) by the Government of India. Kumhar is also known as Prajapati in Varanasi district. Kumhar live as a community and are involved in their traditional activities like pot making, carving and selling in different areas of Varanasi district (Sankuldhara, Kandawa, Naibasti and Tarna). In this paper researcher has used evidences form Naibasti area of Varanasi district.

Traditional Activities: The indigenous practices and procedures of the Kumhar community adopted by their forefathers and practiced in their cultural, communal or professional activities will be treated as the traditional activities of the Kumar community of Varanasi district.

Objectives

The present study aimed to identify the mathematical concepts embedded in the traditional activities of the Kumhar community of Varanasi district.

Method

The method of research used in this study was mainly qualitative in nature with naturalistic inquiry of ethnographic approach.

Sample

The research was conducted on the Kumhar community of Nai Basti area of Pandeypur region *of* Varanasi district of Uttar Pradesh. The observation was made on eleven families who lived as a community. These Kumhar families were identified through snowball sampling technique. Eighteen people of these families, who were involved in the traditional pot making, were selected purposively for the interview.

Tools

Observation schedule and self made semi-structured interview schedule were used for collecting the data. Interview schedule contained four sub areas, *i.e.,* Biographic Information, Traditional

activities, mathematics (logic) and culture, *marketing* related to the Kumhar community. Digital camera and video recorder were also used for data recording.

Miles and Huberman (1994) model of qualitative data analysis technique was used to draw inference from the collected evidences. The obtained evidences through observation and interview were analysed in three steps as shown in the Figure 2. The first step, i.e., data reduction was related with the simplifying, abstracting, and transforming the data that appears from the field notes with a view to make the information intelligible. For example, there were many other evidences of ethnophysics in query making but the investigator has not mentioned it. The second step was matrix display and examination, used to provide an organised and compressed collection of information that permits conclusion drawing and verification. All four areas of information taken from interview were displayed and organised well to complete this step. Last step was related to give common statement for displayed data and assess their implications for the research question, 'What type of mathematical concepts areembedded in the traditional activities of the Kumhar Community of Varanasi district?'

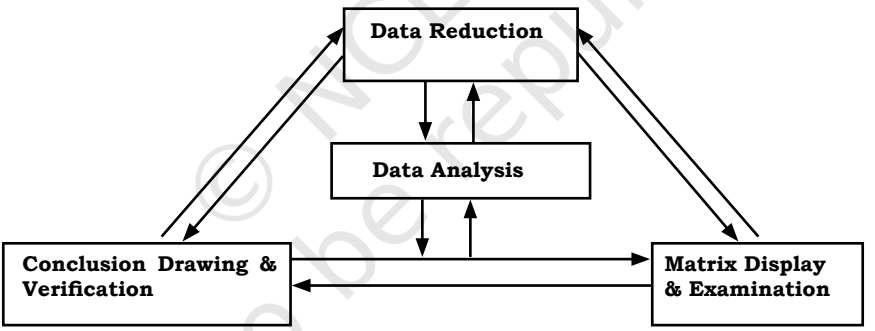


Figure 2 : Data Analysis Cycle

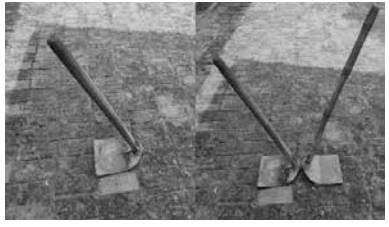
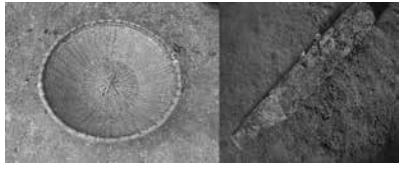
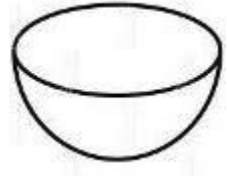
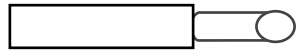
Results and Discussion

The study aimed to describe the mathematical concepts embedded in the traditional activities of Kumhar community. Based on the information obtained from all the respondents and observation by the investigator, the several activities and different types of pots were identified as mathematical evidences. The evidences of procedure of making pots, tools used and other information regarding marketing and storing have been discussed with collaborators and mathematics education practitioners.

Table 1

Identification of Mathematics Embedded in Traditional Activities of Kumhar Community

On the basis of the information about the Kumhar community based on observation and interview researcher identified these following fundamental mathematical concepts.

Tools Used or Traditional Activities	**Reflections of Kumhar Community and Researcher (Analysis and Inference)**	**Mathematical concepts imbedded/Outcomes (with some conditions)**
1. Tools a) *Fawda* (Hoe/Spade), *Khanchi* (Bucket), *Mungri* and *Patiya* (Slab):  *Figure 3, (a): Fawda*  *Figure 3, (b): Khanchi (Bucket); (c) Mungri*	Figure 3 (a) shows the image of *fawda*. As per the need, the *Kumhar* use this tool for digging, collecting soil from the field or pond and also use it in purification of the soil from granule. Their sizes may differ according to the use of different people of family. The *fawda* has two parts vertical (handle) part is made up of wood and horizontal part (base) made up of rectangular iron sheet. The measured angle between horizontal and vertical side was found from 450 to 600. It has a simple mathematical structure but the logics used for making it are very much affiliated to the concept of angle. They always fix the angle of its handle, below 900, i.e., between 450 to 600 so that they can use it easily and make it more useful and productive for their work. The researcher rotated this tool by keeping its base fixed at a point in clock wise or anti-clock wise manner and found the concept of supplementary angle. For example; if the angle between height and base is 600 after rotation it changes to 1200. With this tool and this supported activity we can explain the concept of angle and supplementary angle. *Khanchi* (Bucket), *mungri* and *patiya* (Slab) is used for loading, rubbing and spreading the soil respectively. *Khanchi* is a hemispherical handmade container used for soil loading. Observation of some *khanchi* were done by the researcher and found that 35–40 kg of soil *Kumhar* can load in it. Its a hemispharical shape with depth 20–25 cm. Approximetly all people of kumhar community had crude idea about these measures but some student member of community had specific knowledge about fromula and concept of volume (V = (2 / 3) π r3). *Mungri* is just like a cricket bat, Figure 3 (C & C1) used for rubing the hard soil. After making soil powder they spread a layer at a slab called *Patiya* (a rectangular slab). This process of spreading the soil can be explained as an example of area of rectangle. The community members had better knowledge about how much soil will be sufficent to cover the slab of perticular leangth and width, Figure 3 (C2). This shows the presence of concept of area. During obeservation of another family the researcher asked in different ways about the concept of area. For Instance; if we draw a line at the middle of the slab then how much soil would you need to spread? They replied after thinking and disscussion, 'Half of the previous amount'. This was an another evidence of their understanding of area without using any formula like exb. Most of the family uses thread to find out the length and width of the slab and other tools.	Angle ∟ Supplementary angle. Concept of volume (V = (2 / 3) π r3),  *Figure 3 (b1): Hemisphere*  *Figure 3 (c1): Rectangular and cylindrical shape* Length (l), width(b), Area = lxb  *Figure 3 (c2): Concept of area*

b) *Chaak*

Figure 4 (a); Kumhar people rotating the Chaak

2. Traditional activities or procedures: With the help of the above tools (contained at point 1.) the people of Kumhar community are involved in making different pots and decorative items. Some of them were identified by the researcher:

a) Kneading, making paste and carving:

Figure 5 (a); Kneading (b); Making Paste

Chaak is the main tool used by the Kumhar Community. Without *chaak* we can't imagine the existence of Kumhar community and their traditional activities. *Chaak* is like a flywheel, Kumhar people used to fixes its center on a spike to achieve smooth rotation. They use wooden rod to rotate it. In the given figure 4 (a), A Kumhar is rotating the Chaak with the help of a rod. They rotate it approximately 30–45 second to achieve an adequate rotational motion.

Researcher had asked many questions regarding this activity of rotating the *chaak* and observed it carefully. They told that only one reason to rotate the *chaak* was for pot making. Regarding this some questions were asked to them, what's the logic to set a particular angle between rod and *chaak* during rotation? How do you assess about the particular speed of the *chaak*, that this particular speed will enough to perform the particular activity? On the basis of the responses of the above questions it was concluded that, 'Kumhar set the angle only to achieve a particular rotational motion, for initiating the motion the rod was kept vertical to chaak's surface just like to draw a perpendicular on a plane. Logic behind speed was only that high speed for heavy pot and normal speed for light pot. For making more useful for teaching-learning mathematics the researcher has applied some conditions with *chaak* that if we draw a circle with its diameters we can able to understand the different concept of angle from 00 to 360o as shows in figure 4(b). Its rotational process (Clock and Anti-Clock wise), complimentary, supplementary, acute, right, obtuse, straight and reflex angle can be taught with the help of this tool.'

Figure 5(a), shows a *Kumhar* woman involved in kneading or making the paste of soil for pot making. *Kumhar* people told that they prepare this paste if they have unavailability of pond clay. Before kneading *kumhars* use good ratio of soil and water. Generally this work has been done by the children or women member of the family but for adding water in soil the experienced member of the family perform their role. Because the experienced member have good estimate about the ratio of water and soil. Different family had different making procedure but one thing was observed similar that if they had to prepare one *khanchi* (bucket) clay they added approximately one fourth water in one bucket soil. This refers that the ratio between soil and water added was 4:1. They had inherent knowledge about ratio but they were not aware of mathematical concept of this. When the researcher asked a counter question that if we change the order of these added substances then what will happen? They replied that either we add soil in water or water in soil the outcomes will remain unchanged. This shows that they practices commutative law. (for a defined operation)

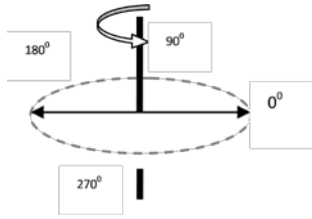


Figure 4 (b): Concept of 0 to 360 degree

Drawing perpendicular (⊥) on a plan from any point.

Concept of Angle from 00 to 3600 from a single *chaak* and its rotational process. (Clock-wise & Anti-clock wise) Complimentary, supplementary, acute, right, obtuse, straight and reflex angle.

Concept of ratio.
Commutative law of mathematics, i.e., A+B = B+A
For example:
Soil + Water = Water + Soil
(For making specific Paste with Defined operations)

They also used associative law of mathematics, i.e., A+(B+C) = (A+B)+C
They draw many patters that are very similar to the mathematical diagrams for drawing colouring and finding area and perimeter, etc.

Figure 5 (c): Carving

Figure 5 (d): Symmetrical Patterns

After making and baking the pots *Kumhar* people prepare a specific colour paste with the help of the soil, water and bark of *catechu* (*kathha*/ *khair*), Figure 5(b). First of all they boil bark of *catechu* and filter it and then use filtered liquid, i.e., *khair* in colour making. Therefore, only three things were mixed (Soil+ water+ *khair*) for simple colouring.

Another family, which had larger business of pots making, prepare these colours differently. As per information provided by them, for preparing colour for 500 *Matkis* of 2 litre they mixed 100 gm *khair*, 50 gm caustic soda, 250 gm powder of bark of mango tree and 2 kg soil.

Here in both evidences it was discussed about the sequencing of added materials and association of one material with rest of the materials. Researcher found that the practices were based on commutative law as well as association also. For example: Soil + (Water + *Khair*) =(Soil + Water) + *Khair*

Kumhar people prepare colours for painting and carving the pots with different traditional diagrams and patterns. Figure 5(c) Shows that a *Kumhar* women involved in painting and carving the pots. They generally use brown colour for painting and white colour (lime/chuna) for carving. The intensity/saturation of colour depends upon the amount of *khair* and water added in the mixture. *Kumhar* people draw indigenous diagrams and patterns on the pots, figure 5(d). Most of the patterns were simple and circular. For example: In figure 5(d), this is a painted *matki*. The line at the bottom of matki is circular, in the middle it is curvy and at the top it is again similar as bottom line and also parallel. It's showing a structure of line and parallel line.

Further at the top of the *matki* the worked pattern is just like a peacock feather. If we draw a straight line at the mid of this structure. It will divide this structure into two symmetrical parts, Figure 5 (d1). This shows the concept of symmetry in patterns.

The concept of symmetry

Drawing Lines (circular/ parallel).

Concept of symmetry

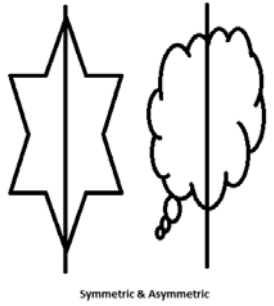


Figure 5 (d1): Symmetry and Asymmetry

b) Making different types of pots: *Kulhad*, *Gamla*, *Matki*, *Deepak*, etc.

Figure 6 (a): Kulhad

The peoples of Kumhar community were following several activities for different needs of pot making, carving, etc. The making of these items is a taking procedure hence the researcher has observed only some of them. Figure 6 (a), shows a *kulhad*, which is used to serve tea in Indian local cultural environment. Its structure is like a conical frustum but it may be different in shape and size. It was measured that every *kulhad* of small size had approximately equal height, weight and water containing efficiency. How that was happening with this activity while they were not used any unit measure norm during process of *kulhad* making? It was happening because of their good estimating power and experience. With the help of this pot we can explain the concept of volume and height, width, latent height, circular bottom etc., and also can use as an example in teaching learning mensuration.

Every step for making pot has a specific logic and some mathematical concepts. Understanding elementary shapes, geometry and practical geometry, concept of symmetry, Visualising solids and shapes, Some concepts of Mensuration

Figure 6 (b): Gamla (Flowerpot)

Figure 6 (c): Matki (Pitcher)

Figure 6 (b), shows *gamla*, it is used mainly for gardening of flowers and light trees. Procedure for making this pot is similar as *Kulhad* but it is large in shape and size. The *Kumhar* people after rotating the *chaak* drag the clay in upward direction with the help of thumb, index and middle figure. Sometimes use proper hand to maintain the shape of the pot and after getting an adequate size cut the pot with a thread. It was observed that the truncation procedure of both *kulhad* and *gamla* are very much similar as the frustum of cone.

Figure 6 (c), shows *matki* (Pitcher), which is mainly used as a water container. Its making procedure was complex but due to lack of proper observation researcher cannot explain clearly. This can be used as a teaching-learning material for explaining the concept of hollow sphere.

The steps involved in making of all these items has a specific type of logic and have some mathematical concepts like understanding elementary shapes, geometry and practical geometry, concept of symmetry, visualising solids and shapes, some concepts of mensuration, area volume, height, lateral height, comparison of shapes and quantities can also be seen.

(Area volume, height, lateral height)
Frustum of cone
concept of hollow sphere.
comparison of shapes and quantities.

b) Cutting the pots from *Chaak*:

Figure 7 (a): Cutting

Figure 7 (b) Spiral type structure

Figure 8 (a): step 1 and 2

Cutting/truncating the pots from *chaak* is a technique as well as skill also. They use a small thread for cutting, Figure 7 (a). During observation it was evident that the base of *kulhad* has a specific geometrical structure. When it was asked to *kumhar* people they told that this is a circular shape, due to friction between thread and base of *kulhad* it is generated. But it can be seen in Figure 7 (b) its structure is like a spiral. Because of circular motion of *chaak* and friction with thread this curve has made up. In mathematics this shape is called spiral (r (t)=1/t or 1/√t).

On the basis of above analysis, interpretation of making procedures of pots as shows in Figure 6 (a), (b) & 7 (a), (b) an another concept can be drawn with the help of some conditions. Let us suppose in the cutting process of *kulhad* and *gamla* if we consider it as right circular cone and change the angle of truncation we can find different kind of geometrical structures, Figure 7 (c).

With applying some conditions we can generate the different concepts for teaching learning mathematics.

Anwan is an oven or kiln used to fire the pots. The process of preparing *anwan* was observed keenly by the researcher and for better understanding its working procedure has broken in six steps, Figure 8 (a b and c). *Kumhar* people prepare a hole in the ground. Generally the shape of ground hole was hemispherical. Some families were made it rectangular also. They prepare *anwan* for baking the pots as per their space and need. They arrange iron rods as a grill at the upper surface of the ground so that the space behind rods can remain for firing and proper air flow.

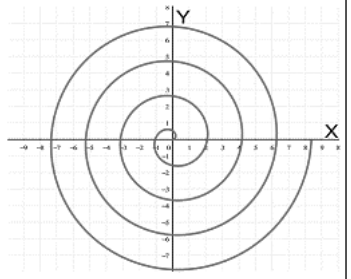


Figure 7 (b1): Shape of spiral

Conic section; circle (1), ellipse(2), parabola(3), hyperbola(4)

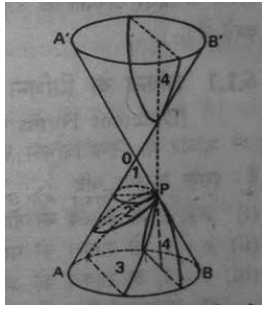


Figure 7 (c): Conic Section

The mathematical concept of sequencing, forward and reverse counting, arrangement of different types of a shapes, concept of reversibility 1>2>3>4...= 4>3>2>1, and

 *Figure 8 (b): Steps 4 and 5*  *Figure 8 (c): step 5 and 6*	After that they cover the grill with husk, dung, straw and coal, Figure 8(a): Step 1 and 2. After that they count and arrange the all unbaked pots upon it with specific steps, i.e., large pots in first few rows and smaller pots in the last few rows, Figure 8 (b): Step 3 and 4. It shows the concept of sequencing and the concept of reversibility embedded in it. At every step they make a layer of dry grass and coal powder. After completing the last step *Kumhar* people make a plaster upon the arranged pots with clay, slurry and straw, Figure 8 (c); step 5. Further burn the anwan from bottom side and leave it for baking for six to eight hours. In this process of making *anwan*, *Kumhar* people use ethnophysics rather than ethno-mathematics. For example; the baking/firing process of *anwan* is very much isolated in nature. But the logics used to prepare it are more mathematical. After firing *Kumhar* people excluded the pots from ash in a sequence (last row first and first row in the last), Figure 8 (c); Step 6. Here, the process of exclusion can be used as an example of last in first out and first in last out in Q-theory.	Q-theory (first in-first out/last in-first out and first in-last out) of operations research are embedded in this activity of *Kumhar* community.
3. Marketting/Selling: to offer people to buy something	Marketing is related to the ultimate aim of their practices because all the activities which are conducted are there because of public demand. The educational status of *Kumhar* people is not so satisfactory that they can organise their work and products at higher level of marketing but they use indigenous practices to perform their marketing process (Kotte and Surendra, 2016). It was asked to them, How do you calculate the price of the pots? All people had no any idea for this question but some experienced members who were not very educated had the knowledge about estimation of price. For example one member explained it as, "The price of the pots depends on the price of coal because we buy it from market and rest of the things used in making and baking are homemade. So if we have to make 4000 *kulhad* and the price of coal per Kg are ₹60 4–6 kg coal used for one time *Anwan* preparation. Let us suppose other material used is of ₹100 And day wise labour is ₹300 (keep in mind that for making ₹4000 *kulhad* the 3–4 days expended) Then, ₹360 (for coal) + ₹100 (for other things)+ ₹1200 (labour) = ₹1660/-	Concept of estimation of price, Concept of Profit and lose, Unitary method.

	So, ₹416 for 1000 of *kulhad* and approximately ₹42 for 100 *kulhad* and ₹4 16 *paisa* for 10 *kulhad*." After that he discussed the profit behind their selling that, "if the amount spent will be more than the selling then our business will be in loss and if not, then it will be in profit." Here it can be conclude that they have the concept of estimation of the price which they calculate it by a base unit of 10, 100, and 1000 and also concept of profit. Similarly, one woman member of a family has discussed and calculated the price of one *kulhad* for selling. It was evident that she also used the concept of Unitary method as a technique for solving a problem by first finding the value of a single *Kulhad* then applying it to all.	

Educational Implication: This study highlights the useful aspects of cultural mathematics and traditional practices of Kumhar community to the curriculum planer and textbook writers in Indian school setting. This will also enhance teachers to adopt innovative strategies of teaching mathematics to learners. All mathematical concepts stated in Table can be used for teaching-learning of mathematics and some points can be specified as:

- The mathematics embedded in the tools used by the *Kumhar* community can be used as an example during teaching the concept of angle, supplementary angle, concept of volume, length, width, and area. Further rectangular, cylindrical and spherical shapes can also be introduced.
- From the use of a model of *Chaak* or with discussion the circular motion of the *Chaak*, the teachers can develop the concept of 00 to 3600 in the students, also the concepts of acute, obtuse, straight and reflex angle.
- The mathematics teacher can use the process of kneading and making paste for color as an example of commutative and associative law. The concept of symmetry can also be developed from carving done on the pots by the *Kumhar*.
- The different types of pots can be used as an example of identification of geometrical shapes.
- Preparation of anwan includes many scientific steps; some of them can be elaborated with students for teaching 'sequencing the things' at lower classes.
- Kumhar Community has indigenous knowledge about estimation of price of the pots, unitary method and profit-loss. The mathematical problems of profit-loss can be framed by using the practices of *Kumhar* people.

Conclusion

The National Curriculum Framework (NCF, 2005) has suggested the need for developing the ability for mathematisation in the child and provided many recommendations to solve the hurdles and one of them is to enable children to observe the relevance of mathematics to people's lives. This paper is also reflecting the same ideas and advocates multi-cultural and ethnomathematical aspect of teaching learning mathematics from Kumhar community. On the basis of the above discussions and analysis we can conclude that if in a single community like Kumhar, these several mathematical

concepts are embedded, then in the country like India where the huge cultural diversity exists, such type of investigations are needed. Many people are unconsciously applying mathematical skills in everyday life without realising its importance. There are great probabilities that such skills, if transferred to schools, could advance the teaching and learning of mathematics. Therefore, the skills of those people who applying mathematics in their cultures without any formalised training, could contribute positively towards better performance of the learners in the classroom.

Acknowledgements: I would like to express my gratitude towards all the participants and respondents who have provided in-depth information for the needs of this study. And also I want to make thanks to my Ph.D. supervisor, who have given me this opportunity to work on this area of mathematics education with free hand.

References

Agrawal, V.S. 2013. *Vedic Mathematics.* Motilal Banarasi Dass Publishers Private Limited. New Delhi.

Ascher, M. 1991. *Ethnomathematics: A Multicultural View of Mathematical Ideas.* Pacific Grove,Calif: Brooks/Cole.

Abiam, P.O., O.S. Abonyi., J.O. Ugama. and Okafor. G. 2016. Effect of Ethnomathematics Based Instructional Approach on Primery School Pupils' Achievement in Geometry. *Journal of Scientific Research and Reports.* 9 (2). pp. 1–15.

Bishop, A.J. 1988. *Mathematical Enculturation: A Cultural Perspective on Mathematics Education.* Dordrecht. Kluwer Academic Publishers. The Netherlands.

———. 2002. Research Policy and Practice: The Case of Values. In P. Valero & O. Skovsmose (Ed.). *Mathematics Education and Society.* Proceedings of the Third International Mathematics Education and Society Conference MES3. Vol. 2, No. 2. pp. 227–233. Centre for Research in Learning Mathematics. Denmark.

D'ambrosio, U. 1985. Ethnomathematics and its Place in the History and Pedagogy of Mathematics. For the Learning of Mathematics. 5. pp. 44–48.

———. 1990. *Etnomatemática [Ethnomathematics].* São Paulo, SP, Editora Ática. Brazil.

———. 2001. *Etnomatemática: Elo entre as tradicoes e a medernidade [Ethnomathematics: Link between Traditions and Modernity].* Sense Publishers. The Netherlands.

Gerdes, P. 1996. How to recognise hidden geometrical thinking? A contribution to the development of anthropological mathematics. *For the Learning of Mathematics.* 6 (2), pp. 10–12.

GERDES, P. 2000. Ethnomathematics as a New Research Field, Illustrated by Studies of Mathematical Ideas in African History. *International Journal of Mathematics Education.* 3 (.4), pp. 314–325.

GUPTA, O.P. 2009. Ethnomathematics: The Integration of Pedagogy of Social Justice and the Culturally Embedded Practices. Retrieved from http://www.ncert.nic.in/pdf_files/Ethnomathematics.pdf NCERT, New Delhi.

HARA-GAES, M. 2005. Ethnomathematics: An Investigation of the Mathematics Embedded in the Cultural Activities of the Damara People in the Khorixas Area (Master's thesis, University of Namibia). Retrieved from http://repository.unam.edu.na/bitstream/handle/11070/1498/Hara%23Gaes2005.df

KOTTE, P. AND M. SURENDRA. 2016. An Anthropological Study of Kummara Community in Naidupalem Village, Nellore District, AP, India. *Imperial Journal of Interdisciplinary Research* (IJIR). 2 (12), pp. 1707–1712.

KRAMER, S. 1991. Socio-economic Aspects of Udaipur City Potters During 1982–82. Masters thesis,University of Rajasthan.

KURUMEH, M.S.C. 2004. Effect of Ethnomathematics Approach on Students' Achievement and Interest in Geometry and Mensuration. Doctoral dissertation, University of Nigeria. Retrieved from http://www.unn.edu.ng/internals/repository/view/MTYwNjY

MILES, M.B. AND A.M. HUBERMAN. 1994. *Qualitative Data Analysis.* 2nd ed., pp. 10–12. Newbury Park, CA, Sage.

MOGEGE, M. 1999. An Exploration Based on String Figures Culture. *Games and Mathematics Education.* Indigenous Technologies. Pretoria.

NATIONAL COUNCIL OF EDUCATIONAL RESEARCH AND TRAINING. 2005. National Curriculum Framework.Retrieved from http://www.ncert.nic.in/rightside/links/pdf/framework/english/nf2005.pdf

NATIONAL COUNCIL OF EDUCATIONAL RESEARCH AND TRAINING. *National Focus Group on Teaching of Mathematics 2006.* Position Paper National Focus Group on Teaching of Mathematic. ISBN 81-7450-539-3. Retrieved from http://www.ncert.nic.in/new_ncert/ncert/rightside/links/pdf/focus_group/math.pdf

ZASLAVSKY, C. 1973. *Africa Counts: Number and Pattern in African Culture.* Third revised ed.,1999. Lawrence Hill Books. Chicago.

Life Skills

Predictors of Well-being among School Going Students

ALKA SETH* AND NOVRATTAN SHARMA**

ABSTRACT

Promotion of mental health includes the growth of psychological resources including improvement in quality of life, preventing mental disorders and increasing satisfaction and happiness. In today's world of stress and competition, students are required to imbibe some kind of skills, which can enhance their well-being and mental health and enable them to adapt and get the right direction in life. Well-being for life lies in feeling comfortable, healthy and happy. Present study takes into account the role of life skills in predicting well-being among adolescents. A group of 300 adolescents with an age range of 12–16 years from a CBSE affiliated school of Kaithal district in Haryana formed the sample of study. Tools used for present study were Life Skills Assessment Scale and Well-being Manifestation Scale. Results of the study showed high correlation between well-being and different components of life skills. The regression analysis of data showed that different variables of life skills were significant predictors of well-being of students. The study has implications in terms of organising programmes on training of life skills for students in schools. The study also emphasises on the development of modules of life skills for adolescents.

Keywords: *Life Skills, well-being and adolescents.*

सार

मानसिक स्वास्थ्य को बढ़ावा देने हेतु जीवन की गुणवत्ता में सुधार, मानसिक विकारों का निवारण, संतुष्टि और खुशी में वृद्धि सहित अन्य मनोवैज्ञानिक संसाधनों का समावेश आवश्यक है। आज के तनाव और प्रतिस्पर्धा की दुनिया में, छात्रों को कौशलों को आत्मसात करने की आवश्यकता होती है, जो उनके कल्याण और मानसिक स्वास्थ्य को बढ़ा सकते हैं और उन्हें जीवन में सही दिशा प्राप्त करने में सहायक होते हैं। स्वस्थ जीवन के लिए आराम

**Assistant Professor*, Department of Psychology, C.R.S. University, Jind (e-mail: alka.bhalla05@gmail.com)

***Professor*, Department of Psychology, M.D. University, Rohtak.

और प्रसन्न महसूस करना आवश्यक है। वर्तमान अध्ययन किशोरों के जीवन कल्याण की भविष्यवाणी करने में जीवन कौशलों की भूमिका पर केंद्रित है। हरियाणा में कैथल जिले के एक सी.बी.एस.ई. (CBSE) संबद्ध विद्यालय से 12–16 वर्ष की आयु सीमा के 300 किशोरों के एक समूह ने अध्ययन में भाग लिया। वर्तमान अध्ययन के लिए लाइफ स्किलस असेसमेंट स्केल और वेल-बीइंग मैनिफेस्टेशन स्केल नामक उपकरणों का उपयोग किया गया। अध्ययन के परिणामों में जीवन कौशल के विभिन्न घटकों और कल्याण के बीच उच्च सहसंबंध पाया गया। प्रदत्त के प्रतिगमन विश्लेषण से पता चला कि जीवन कौशल के विभिन्न चरों का छात्रों के कल्याण में महत्वपूर्ण भूमिका है। प्रस्तुत अध्ययन विद्यालयों में छात्रों के लिए जीवन कौशलों के प्रशिक्षण हेतु कार्यक्रमों के आयोजन की सिफारिश करता है। यह अध्ययन किशोरों के लिए जीवन कौशलों के मॉड्यूल के विकास पर भी जोर देता है।

Introduction

Young people represent the future of the country. The parents, teachers, and all others concerned try to inculcate confidence, values, health, happiness and many more positive traits among them. But what we consider a source of happiness and good mental health for our young ones like unconditional love, good grades, and fulfilling their wishes may not be enough. Therefore, the efforts need to be made to capitalise the strengths of this period and foster positive attributes among them. Efforts are required for strengthening of psychological resources including awareness about self, improvement in quality of life by developing critical and creative thinking, preventing mental disorders by dealing with stressful situations of life with interpersonal skills and effective communication skills and eventually leading to satisfaction and happiness in life.

Well-being is a multi-dimensional concept, extended and context specific too. It is as outstretched as livability, abundance, social support, community credential, social adherence and the interception of mental ailment. It has functional utility and is a crucial element of the World Health Organisation's interest. A state of well-being leads to mental health in which an individual becomes aware of their own potential, can handle normal stresses of life, can work effectively and fruitfully, and is capable to contribute to the community (WHO, 2012). In recent years, evidence point out to the pivot determinants of young one's well-being like adult-child relationships, a positive self-esteem, a sense of belonging, opportunities in given responsibilities and involvement

in decision-making (Bernard, Stephanou, and Urbach,2007; Eckersley, 2008).

A positive behaviour that encompasses a mix of knowledge, behaviour, attitudes and values and designates the possession of certain skills and know-how to do something positively, or reach a goal is referred to as life skills. Strength of this behaviour depends upon the depth of the skills acquired by the individual. Over the past few years, educators and policy makers are giving considerable emphasis on life skill training programmes as a potential tool to nourish young people for a successful and happy life in this fast changing and a globalised world. There is an ever growing urgency for life skill training to help youth to manage smooth transitions in different strata of life like home to school, school to work and managing personal life events, etc. Life skills are instilled as a product of formative churning of knowledge, impressions, encounters and experiences at both phases individual as well as social. They are part of one's day to day life and work. Life skills are in continuous evolution in both the individual contexts of personal and that of the economic, social or cultural. World Health Organisation has given a list of ten life skills that are the core of skill dependent resourcefulness to promote the health and well-being of children and adolescents. Ten core life skills, according to World Health Organisation (1996) are— self awareness, empathy, effective communication, interpersonal relationships, creative thinking, decision making, problem solving, coping with stress, and coping with emotions.

Life skills education is an emerging area of scientific study. They are essentially those abilities that help in promoting well-being and competence in young people as they face the realities of life. For young people, life skills are the abilities which prepare them to deal with age and experience appropriate challenges. In view of the role of life skills as an important factor in enhancing well-being, the present study investigated the relationship of different variables of life skills with well-being. It also analysed the role of life skills in predicting well-being among school going students.

Objectives of the Study

The study was conducted with the following objectives.

- To examine the relationship between well-being and various dimensions of life skills.

- To study the possible role of dimensions of life skills in determining well-being.

Method

Sample

In this study, a sample of total 300 students studying in Classes VII, VIII, IX and X was selected from CBSE affiliated Public Schools of Haryana situated at district Kaithal. The age range of the students varied from 12 to 16 years.

Tools

The following tools were used to collect the requisite data for the study:

1. *Well-being Manifestation Measure Scale* (WBMMS)*:* This scale was developed by Masse, Poulin, Dassa, Lambart, Belair and Battaglini in 1998. The scale includes 25 items having six factors. It is a five point rating scale from 1 to 5. The six factors or subscales of the WBMMS are Control of Self and Events (4 items); Happiness (5 items); Social Involvement (4 items); Self Esteem (4 items); Mental Balance (4 items); and Sociability (4 items). Total score range lies between 25 to 125. The participants respond on a five-point frequency scale (Never, Rarely, Half the Time, Frequently, Always). An overall Cronbach's alpha of 0.93 for the scale, and a range of 0.71 to 0.85 on the subscales has been reported.
2. *Life Skills Assessment Scale (LSAS):* Developed by Nair, Subasree and Ranjan (2010), this scale consists of 100 items measuring 10 dimensions of life skills, viz. Self-Awareness, Empathy, Effective Communication, Interpersonal Relationships, Creative Thinking, Critical Thinking, Decision Making, Problem Solving, Coping with emotions, Coping with Stress. Each item is responded on the 5-point scale. It has both positive and negative items. Items are scored individually as well a global score of life skills. Split-half reliability of scale is found to be 0.82. The final summated scale had a correlation coefficient of 0.84. The criterion validity was established by conducting structured interview with teachers and students on high and low scorers in life skills. The correlation between percentage obtained by each student in each skill and the teacher's judgment on each student were calculated which indicated 89 per cent concurrence.

Procedure

In the initial stage, the participants were contacted in their respective classes and their willingness to participate in the study was obtained. Subjects were first administered Life Skills Assessment Scale and thereafter Well-being Scale was administered to them. All subjects were assured that their responses would be kept confidential.

Results and Discussion

The coefficients of correlations were computed to study the relationship of wellbeing with different variables of life skills using Pearson Product Moment method. In order to have a prudent picture of contributions of different dimensions as the predictors of well-being, step-wise multiple regression analysis was done.

The correlations are shown in Table1. A careful analysis of Table 1 depicts significant positive correlation between well-being with Self Awareness, Empathy, Effective Communication, Interpersonal Relationships, Creative Thinking, Critical thinking, Decision Making, Problem solving, Coping with Emotions, Coping with Stress and Global scores of life skills.

Table 1: Correlation of Well-being with Life Skills

Life Skills	Well-being						
	Self Esteem	Mental Balance	Social Involvement	Sociability	Control of Self & Events	Happiness	Overall Well-being
Self Awareness	0.19**	0.19**	0.19**	0.22**	0.28**	0.17**	0.29**
Empathy	0.08	0.18**	0.20**	0.15**	0.20**	0.09	0.21**
Effective Communication	0.15**	0.08	0.16**	0.09	0.14*	0.12*	0.17**
Interpersonal Relationships	0.27**	0.11*	0.21**	0.20**	0.18**	0.18**	0.27**
Creative Thinking	0.12*	0.15**	0.17**	0.16**	0.23**	0.11*	0.22**
Critical Thinking	0.24**	0.28**	0.30**	0.26**	0.36**	0.18**	0.38**
Decision making	0.23**	0.18**	0.28**	0.11*	0.27**	0.13*	0.27**

Problem Solving	0.22**	0.23**	0.24**	0.22**	0.32**	0.20**	0.34**
Coping with Emotions	0.12*	0.16**	0.19**	0.18**	0.15**	0.16**	0.23**
Coping with Stress	0.16*	0.04	0.13*	0.03	0.09	0.13*	0.14*
Global Score	0.33**	0.29**	0.36**	0.31**	0.41**	0.28**	0.47**

N=300, **p<0.01,*p<0.05

The significant correlations between Well-being and life skills ranged from 0.11–0.47. Results revealed that self awareness was positively related to self esteem, mental balance and social involvement (r=0.19), sociability (r=0.22), control of self and events (r=0.19) and happiness (r=0.17). The results depicted that empathy was associated positively with mental balance (r=0.18), social involvement (r=0.20), sociability (r=0.15), control of self and events (r=0.20). Another dimension of life skills, i.e., effective communication was also significantly positively related to self esteem (r=0.15), social involvement (r=0.16), control of self & events (r=0.17) and happiness (r=0.12). Similarly various dimensions such as interpersonal relationships, creative thinking, critical thinking, problem solving, decision making, and coping with emotions were also significantly positively related to different dimensions of well-being. However coping with stress was significantly positively correlated to self esteem, mental balance, social involvement and happiness but not significantly correlated to sociability and control of self and events. The results revealed that life skills were positively associated with well-being.

The global life skills score was positively related to self esteem (r=0.33), mental balance (r=0.29), social involvement (r=0.36), sociability (r=0.31), control of self and events (r=0.41), happiness (r=0.28) and overall well-being (r=0.47). Thus, results showed that adolescents' life skills are positively related to their well-being.

Although correlation is very useful statistical tool for observing the associations between the variables, yet it does not serve any information regarding the predictors of variables. The step wise regression was used, while taking Well-being as dependent variable and different dimensions of life skills viz. Self Awareness, Empathy, Effective Communication, Interpersonal Relationships, Creative Thinking, Critical thinking, Decision Making, Problem solving,

Coping with Emotions Coping with Stress as independent variables. Table 2 shows the results of stepwise regression analyses.

Table: 2 Predictors of Well-being as Shown by Stepwise Multiple Regression

Step	Predictor Variables	Multiple R	R2	B	F Value
	Coping with Stress	0.14	0.02	0.14	6.35
	Effective Communication	0.17	0.03	0.17	9.84*
	Empathy	0.21	0.04	0.21	14.58**
	Creative Thinking	0.22	0.05	0.22	15.64**
	Coping with Emotions	0.23	0.05	0.23	17.00**
	Interpersonal Relationships	0.27	0.07	0.27	24.71**
	Decision making	0.27	0.07	0.27	23.67**
	Self Awareness	0.29	0.08	0.29	28.99**
	Problem Solving	0.34	0.11	0.34	38.93**
	Critical Thinking	0.38	0.14	0.38	50.76**

N=300, *p<0.05,**p<0.001

It is apparent from Table 2, that there are nine significant predictors of well-being with an overall multiple R of 0.38. Critical Thinking multiple R for predictor is 0.38 and R^2=0.14 (F= 50.76, p<.001), which means that critical thinking has contributed for 14 per cent of variance in well-being. Likewise, Problem solving is another factor, contributed for 11 per cent, Self awareness has contributed (8 per cent), Decision making and Interpersonal relationship contributed (7 per cent, each) and creative thinking and coping with emotions contributed (5 per cent each), Empathy contributed (4 per cent) and Effective communication contributed respectively 3 per cent to well-being. Composite contributions of these variables were found to be 66 per cent of variance in wellbeing. However, well-being was not significantly influenced by coping with stress dimension of life skills.

The results of the present study have found support from other studies (e.g., Holopainen, Lappalainen, Junttila and Savolainen, 2012; Haji, Mohammadakhani and Hatami, 2011; Nair, Ravindranath, and Thomas, 2013; Seth and Sharma, 2017).

Conclusion

The concept of Well-being is multidimensional and is generally connected to the notions of health, happiness and life satisfaction. According to the World Happiness Index, India is at 140th Position out of 156 countries (Helliwell, Layard and Sachs, 2019). This report clearly represents the grave situation as it is the clear indicator of mental health of our country. Due to increasing complexities in modern societies, emphasis is given more on preventive approach to mental health. Most of the risk taking behaviors and psychological problems among children and adolescents emerge during adolescent period which can be preventable through universal preventive programs and promotion of school mental health programs. Promoting competencies has the potential to prevent high risk behaviours, psychological problems and enhance resilience among the children and adolescents. The present study drives the focus on life skills as predictors of well-being among adolescents. It draws attention of mental health professionals, psychologists and policy makers to work on life skills of adolescents for enhancing their wellbeing and mental health. Since the individual rather than the system is recognized as the basic unit of the society, it is essential and a must to help adolescents to develop skills to handle a wide variety of choices, challenges and stressors in their lives and work towards better health. Life skills education programs in schools, colleges and universities are essential measures to assist our young ones to develop a more healthy and positive approach for life. It is a recommended tool, which has to be implemented at policy level with more firm actions.

References

Bernard, H., A. Stephanou and D. Urbach. 2007. *ASG Student Social and Emotional Health Report: A Research Project Conducted by the Australian Council for Educational Research.* Australian Scholarships Group. Melbourne.

Eckersley, R. 2008. Never Better-or Getting Worse? The Health and Well-being of young Australians. Weston: Australia 21.

Haji, T., S. Mohammadakhani and M. Hahtami. 2011. The Effectiveness of Life Skills Training on Happiness, Quality of Life and Emotional Regulation. *Procedia — Social and Behavioural Sciences.* 30 (2011): pp. 407–411.

Helliwell, J., R. Layard and J. Sachs. 2019. *World Happiness Report 2019.* Sustainable Development Solutions Network. New York.

HOLOPAINEN, L., K. LAPPALAINEN., N. JUNTTILA AND H. SAVOLAINEN. 2012. The Role of Social Competence in the Psychological Well-being of Adolescents in Secondary Education. *Scandinavian Journal of educational Research.* 56 (2). pp. 199–212.

MASSE, R., C. POULIN., C. DASSA., J. LAMBERT., S. BELAIR AND A. BATTAGLINI. 1998A. The Structure of Mental Health Higher-order Confirmatory Factor Analyses of Psychological Distress and Well-being Measures. *Social Indicators Research.* 45. 475–504.

NAIR, R., R.A. SUBASREE AND RANJAN. 2010. *Life skills Assessment Scale.* Rajiv Gandhi National Institute of Youth Development.

NAIR, A.R, S. RAVINDRANATH AND S. THOMAS. 2013. Can Social Skills Predict Well-being? An Exploration. *European Academic Research.* 1(5). pp. 712–720.

SETH, A. AND N. SHARMA. 2017. Effect of Life Skill Training on Well-being of Adolescents. *International Journal of Psychosocial Research.* 6(1). pp. 45–50.

WORLD HEALTH ORGANISATION. 1996. *Life Skill Education: Planning for Research.* Division of Mental Health and Prevention of Substance Abuse. WHO. Geneva.

WORLD HEALTH ORGANISATION. 2012. *Making Health Services Adolescent Friendly Developing National Quality Standards for Adolescent Friendly Health Services.* WHO. Geneva.

Summary of ERIC Projects

A Study of Language across the Curriculum Pedagogy on Students' Learning

KIRTI KAPUR*

Introduction

The study was undertaken to examine the role of language across the curriculum and to understand if, and how, classroom talk can help children learn to use language effectively as a tool for thinking collaboratively. It was conducted in the five representative schools of Delhi. The representative schools were KV, JNV, NDMC, RPVV and one private school, i.e., DAV. This pilot study was designed as a multi-phase experimental study. The key variables of 'classroom talk' and 'critical thinking' were studied through a mixed method approach. This included qualitative exploration using in-depth interviews, focus group discussions and field observation along with quantitative mapping of classroom practices. Both anecdotal and observed data contributed to the analysis of this study.

The importance of Language across the Curriculum (LAC) has been recognised widely in the literature. The *National Curriculum Framework* (*2005*) has also stated that, 'every teacher ipso facto is first a language teacher and then a subject teacher' that recommends across the curriculum approach towards language development.' Furthermore, when students listen, talk, read, and write in non-language classes their linguistic skills come into play, and can be critical for success. This is why greater interdisciplinary synergies need to be identified and tapped.

Therefore the motivation for the study came from—(i) the growing recognition of Language across the Curriculum (LAC) as both an important concept and a policy and (ii) a desire to evaluate the current state of LAC in the Indian classroom context through a study on the prevalence, and quality, of 'Classroom Talk'. At a more foundational level 'Classroom.talk' is an epistemological position (Mercer: 2016, Lefstein: 2010, Wegerif: 2010) that believes that

* *Professor of English*, Department of Education in Languages, NCERT, New Delhi- 110016 (e-mail: kkapur07@gmail.com)

dialogue lays the true foundation of learning. When teachers and learners both express their thoughts, classroom dialogue becomes generative, i.e., gains the power to generate and produce knowledge. When teachers and learners both express their thoughts, classroom dialogue becomes generative, i.e., gains the power to generate and produce knowledge.

Objectives of the Study

The objectives of the study were to:

1. understand the nature of ongoing classroom discourse across curricular areas (Science, Social-science, Mathematics, English)
2. establish and map the relationship between classroom talk and critical thinking among students in LAC curriculum
3. study the potential and impact of learner-centered pedagogy on students' experience of teaching-learning
4. explore how teachers' preparedness and understanding of LAC impacts classroom practices.

Method

The study was conducted in three phases. Phase I established the baseline through stakeholder interviews and focus groups. Phase II gave interventions through workshop and FGD, and develop activities or tasks as exemplars for the classroom teaching learning process with teachers, and Phase III was concerned with going 'back to the classroom', and observe the impact of interventions through workshops and LAC training. The researcher had access to eight classes across English, Math, Science, and Social Science from Classes 6–8 per school. Overall 38 classes were observed by the researcher and of these 20 were revisited as the experimental group. Also, there were no children with special needs in the classes which were observed in the selected schools.

Results

Opportunity to Use Classroom Talk More Effectively

The results revealed that classroom talk in the selected schools was largely bilingual interaction. The primary type of talk included teacher and pupil conversations such as the teacher's explanation of a topic, teacher's questions, teacher's feedback, and modification of the teacher's speech; as well as, responses and questions by students. Student to student interaction was limited.

The students generally adjusted their language while responding to questions to match the language used by the teachers while asking questions. In instances where questions were translated into their mother tongue, students assumed that the questions were in english. Similarly, the students strived to adjust the language of their questions to the language used by the teachers for explaining concepts or questions.

For example in Phase I, it was common to see teachers using conclusive statements while teaching and students giving choral (yes or no) responses. However, in Phase III of the study, teachers were successful in making learner involvement more visible by phrasing classroom questions differently and designing tasks that entail recapping, reformulating, elaborating, and questioning — thereby expanding the range of classroom talk.

By no longer restricting themselves to 'what, when' type of interrogative words to assess students' use of language and conceptual clarity teachers in Phase III were able to also evaluate their critical thinking abilities. Invitational cues like — Explain, Describe, Examine, Discuss — addressed the quality of classroom talk, language proficiency, conceptual clarity, and HOTs. This was reinforced in responses by students. They cited boredom and difficulty, due to 'lack of comprehension', as common reasons for disliking a particular subject or class. For such subjects, their responses clearly showed that there was little space for classroom, talk or dialogue or discussions or any kind of learner centred activity in the form of peer or group work. It is evident that LAC can provide opportunities for teachers to address these issues because linkages across subjects can motivate learners to participate in subjects that may not be their personal favourites.

Heads of institutions identified— (i) gaps in english language skills among teachers and (ii) lack of appropriate teacher-talk affecting skills or learning of students. They expressed the need for correlating a teacher's classroom pedagogy and expression with learners' performances and going beyond designating a specific language as the focus of input. The respondents unanimously felt that teachers should be motivated through trainings, openness in accepting bilingualism as a stepping stone to articulation in english and through using ICT within the school and beyond. Designing activities that encourage discussion on engaging topics was seen as simple and low-barrier intervention.

In overall terms, the study suggests that classroom based tasks or activities are necessary to make classrooms learner centred. It reveals opportunities for teacher trainers to introduce the teachers to tools and techniques for leveraging classroom talk for learning. For teachers, it highlights the benefits of designing activities keeping in view learners potentials to enhance critical thinking. We must, however, also acknowledge that this can only be fostered when activities within a classroom are aligned with the rest of the school. Achieving a common vision though requires engaging students in reflection oriented processes. Schools would require hand holding and training for developing a LAC pedagogy. That said, the spirit of exploring the expectations and goals of their students, displayed by some teacher, is a sign that there is desire for an effective and positive learning environment from all stakeholders.

References

MERCER, N. 2019. Language and the Joint Creation of Knowledge. *The Selected Works of Neil Mercer*. Routledge. New York.

LEFSTEIN, A. 2010. More Helpful as Problem than Solution: Some Implications of Situating Dialogue in Classrooms. In K. Littleton, & C. Howe (Eds.), *Educational Dialogues: Understanding and Promoting Productive Interaction.* pp. 171–190. London, New York: Routledge. USA.

WEGERIF, R. 2010. *Mind Expanding: Teaching for Thinking and Creativity in Primary Education.* McGraw Hill, England.

Developing a Framework of Pedagogical Content Knowledge on Arithmetic for the Primary School Teachers of Mizoram

LOKANATH MISHRA*

Introduction

In order to live life to the fullest and in an effective way, quality of education is very important. Teachers are liable for delivering best knowledge for the welfare of people, society and the whole nation. Pedagogical Content Knowledge (PCK) helps teachers to transmit their knowledge to the students in an effective way. Having in-depth knowledge and understanding about the content is not enough to be a good teacher, they should be able to communicate it with the students effectively. Therefore, the knowledge of pedagogy is crucial for classroom instruction. Teachers should possess the skills to deliver the content in the most simple and easy way that can be understood by the students. In the process of teaching and learning it's not only students whose lack of understanding of concepts sometimes create misconception, it may also be due to the teacher's wrong delivery of concepts, especially in subjects like arithmetic. Misconceptions are not new in arithmetic but in-depth understanding and vigorous skills of teachers will help to eliminate those misconceptions. According to Shulman (1987, p. 8), PCK is that special amalgam of content and pedagogy that is uniquely the providence of teachers, their own special form of professional understanding. PCK identifies the distinctive bodies of knowledge for teaching. It represents the blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organised, represented, and adapted to diverse interests and abilities of learners, and presented for instruction. PCK is the category most likely to distinguish the understanding of the content specialist from that of the pedagogue. Arithmetic

* *Professor*, Department of Education, *Director,* Faculty Development Center, Mizoram University, Aizawl (email: munumishra7@gmail.com).

is a part of primary school curricula. In the technological era it is an applied subject. The usefulness of arithmetic for daily life is important, its instrumental role in other disciplines, the need for a basic knowledge in many professions and the important role of arithmetic in developing critical reasoning cannot be ignored. There is increasing emphasis on the importance of teaching arithmetic skills in primary schools. Today's mathematics teachers are experiencing major changes not only in subject content they teach but also in the way they teach.

The present research focused on developing a framework on pedagogical content knowledge for primary school teachers teaching arithmetic. Pedagogical Content Knowledge (PCK) is a set of special attributes helping someone transfer the knowledge of content to others. It entails knowledge of how to structure and represent academic content for direct teaching to learners, knowledge of learners thinking, including the common conceptions, misconceptions, and difficulties learners encounter when learning particular content and knowledge of the specific teaching strategies that can be used to address learners learning needs in particular classroom circumstances.

Objectives of the Study

The study was undertaken with the objectives:

1. To analyse the competence, confidence and preparedness of primary school teachers in Mizoram for teaching the arithmetic.
2. To identify the difficulty in arithmetic faced by the teacher.
3. To identify conception, misconception and alternative conceptions of teachers on arithmetic.
4. To analyse and explore the special characteristics of PCK contributing to it being better teacher knowledge for primary school teachers of Mizoram in arithmetic.
5. To design and develop a framework to guide and inform the development of PCK for primary school teachers of Mizoram on arithmetic.
6. To understand the effect of emerging framework for the development of PCK for primary school teachers of Mizoram on the their classroom experiences.
7. To analyse the challenges in the implementation of the new PCK framework.

Method

From all the primary schools in the eight districts of Mizoram, 20 primary schools and 160 primary school teachers (one from each school) were selected to participate in the study. Also, eight teacher educators who were dealing with the pedagogy of mathematics from eight DIETs were included for the study. Further, one best school from each district was selected for implementing the framework on an experimental basis. The questionnaire was used to examine the competence and the confidence of teachers in the teaching of arithmetic. After that, based on the data that emerged from the baseline study, a PCK framework was developed for arithmetic in a workshop. The observation method was followed to understand how the emerging framework for the development of PCK for primary school teachers impacted the teacher's classroom experiences.

Findings of the Study

Findings from this research indicated that the complexity in teaching arises due to a lack of conceptual understanding of the teacher, lack of interest, and extended syllabus. It was also found that there is a need for regular curriculum revision from time to time so that problems faced by the teachers and students can be resolved. The research highlighted that pedagogical content knowledge plays a vital role in preparing teachers for effective teaching and learning. It further revealed different areas in which the students were having alternative conceptions. Majority of the teachers in the study expressed that they try to clear student's misconceptions or alternative conceptions while teaching arithmetic in the class. Chances of arithmetic errors depended both on teacher and student, teachers are required to have conceptual understanding about the content they were dealing in the class in order to avoid ambiguity. When asked about different procedures to clear student's misconceptions or alternative conceptions, majority of teachers responded they use different methods of teaching in order to clear the doubts of the students.

Results showed that teachers were more comfortable with an activity based approach in teaching arithmetics. It involved students as active participants rather than passive learners and focused on learning by doing. It made the classroom environment more vigorous and fruitful that might be the reason teachers were more comfortable with this approach to teach in the actual classroom situation. It highlighted different basic strategies used

by the teachers to help students to overcome their misconceptions or alternative conceptions. These strategies included lesson plan, re-plan, probing student's thinking, variety of teaching and learning strategies to explain concepts, skill in questioning techniques, usage of language of teaching and learning, time utilisation (flow and pacing according to learner ability). All these strategies were used by the teachers at one or the other point of time, but majority of the teachers opined that they used a variety of teaching and learning strategies to explain concepts to the students. The use of different teaching aids in the class helped to create and draw student's attention in the lesson especially at the primary level. It was found that schools should provide financial support for developing teaching-learning materials which would make the classroom environment interesting and effective.

The study further revealed that the majority of teachers perceived that there was less need to emphasise on basic computational skills in teaching arithmetic due to calculators. While some primary teachers emphasised on computational skills and use of their ability and experience in teaching arithmetic rather than using calculator in solving basic mathematical problems. Lastly, the research clearly showed that the majority of teachers expressed low confidence in dealing with certain concepts of arithmetic. Though in some areas like, addition and subtraction, multiplication and division, and tables, etc., teachers expressed high confidence but there were teachers who showed their unwillingness to teach some areas of arithmetic if given an option. When a teacher teaches a particular topic that is out of the interest or having less knowledge of content, there is a chance of error. Specific training on arithmetic is needed as revealed in the previous findings in order to eradicate the errors in the learning teaching process of arithmetic.

Policy Implications

The research recommended teachers' orientation and refresher programme with the right kind of pedagogy to handle difficult areas of arithmetic. Further, it recommended the inclusion of pedagogical content knowledge framework in pre-service and in-service elementary school teacher training programmes. The research suggested that the professional development programmes must provide atmosphere allowing autonomy to both teachers and learners to make teaching-learning interesting and fruitful.

References

SHULMAN, L. 1987. Knowledge and Teaching: Foundations of the New Reform. *Harvard Educational Review*. 57(1). pp. 1–22.

Guidelines for Authors

The articles received for publication in the IER are reviewed by one or more referees for their relevance, clarity, length and style. The opinion expressed in the IER does not necessarily reflect the opinions of the National Council of Educational Research and Training. The IER policy prohibits an author from submitting the same manuscript for concurrent consideration by any other publication.

Articles should be sent in English, typed in double space, on one side of A-4 paper with sufficient margins, to the Academic Editor IER, DER, National Council of Educational Research and Training, Sri Aurobindo Marg, New Delhi 110 016, Tel 26563980 (e-mail: indianeducationalreview.der@gmail.com). All finalised articles should be submitted both in Soft (floppy/CD) and Hard Copy format.

References should be listed at the end of the article, in alphabetical order, as follows:

Lanier, J. and J. Little. 1986. Research on teacher education. In M. Wittrock (Ed.), *Handbook of Research on Teaching*, 3rd ed. Macmillan, New York.

Narayan, Jayanthi and M. Ajit. 1991. Development of skills in a mentally retarded child: The effect of home training. *Indian Educational Review*. vol. 28, No. 3. pp. 29-41.

Diagram or line drawings should be complete and supplied separately, numbered neatly for identification and their position in the text clearly indicated. Tables can be given as part of the text. Captions should be supplied wherever necessary.

In order to prepare the manuscripts, authors are requested to follow the directions in the Publication Manual of the American Psychological Association (1983, 3rd ed.). Specifically, the following points may be taken care of before the typescript is sent to the editorial office:

— Leave a margin of at least one inch on all sides of the paper.
— Double space everything, including references, footnotes, tables and figure captions.
— Type the title of the work, corresponding author's name, complete address, phone number, fax number on a separate page after the title page of the manuscript.
— An abstract of the paper in not more than 120 words should be sent with each manuscript.
— Authors may provide brief descriptions about themselves along with areas of their specialisations.

The views expressed by individual authors are their own and do not necessarily reflect the policies of the NCERT, or the views of the editor.

R.No. 12912/(66)

NCERT JOURNALS

Sl. No.	Title	Single Copy	Annual Subscription
1.	***School Science*** A Quarterly Journal for Secondary Schools	₹ 55.00	220.00
2.	***Indian Educational Review*** A Half-Yearly Research Journal	₹ 50.00	100.00
3.	***Journal of Indian Education*** A Quarterly Journal of Education	₹ 45.00	180.00
4.	*भारतीय आधुनिक शिक्षा (त्रमासिक)* (Bharatiya Aadhunik Shiksha) A Quarterly Journal in Hindi	₹ 50.00	200.00
5.	***Primary Teacher*** A Quarterly Journal for Primary Teachers	₹ 65.00	260.00
6.	*प्राथमिक शिक्षक (त्रमासिक)* (Prathmik Shikshak) A Quarterly Journal in Hindi for Primary Teachers	₹ 65.00	260.00

Subscriptions are invited from educationists, institutions, research scholars, teachers and students for the journals published by the NCERT.

For further enquiries, please write to:

The Chief Business Manager
Publication Department, NCERT
Sri Aurobindo Marg, New Delhi 110 016
e-mail: cbm.ncert@nic.in
Phone No. : 26852261

Published by the Head, Publication Department, National Council of Educational Research and Training, Sri Aurobindo Marg, New Delhi 110 016 and printed at Educational Stores, S-5, Bullandshahar Road Industrial Area, Site-I, Ghaziabad (UP).