Effect of ICT Mediated Interdisciplinary Approach of Learning Mathematics on Elementary Students

A Research Project under ERIC

PAC 16.12

2017-18

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एन सी ई आर टी
NCERT

Submitted by

R.K. Nayak
Principal Investigator

L.S. Chouhan
Co-Investigator (I)

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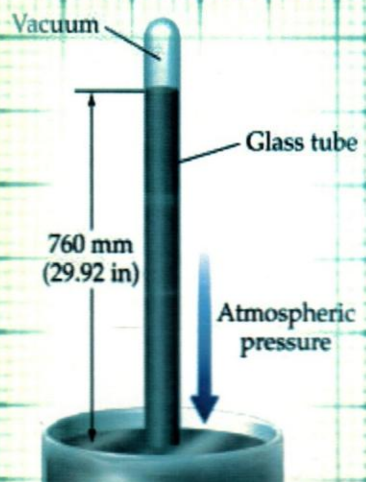
Co-Investigator (II)

Regional Institute of Education (NCERT)

Shyamla Hills, Bhopal-13

Ethnomathematics

By R.K. Nayak



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Abstract

This *Posttest only Equivalent Groups* experimental study compared a procedure that is the *ICT Mediated Interdisciplinary Approach (IMIA)* for helping a section of eighth class students to be better able to improve the *performance levels* and *process skills* identified by the researchers. The performance levels were assessed using *Performance Assessment Rubric (PAR)- Teacher's Perception*; the process skills were assessed along the *Engagement assessment Rubric-Peer's Perception;* both the rubrics were developed by the researchers. It was predicted *IMIA* would improve the *performance levels (Emerging, Beginning, Developing, Expanding, and Proficient)* and *process skills(Meaning Making, Drafting, and Reflecting)*; four separate Chi square tests were conducted to test the relationship between the treatment and achievement of performance levels and process skills obtained along the *PAR and EAR.* A variety of contextual problems from across subjects like physics, chemistry, biology, ecology, biodiversity, geology, geography and surroundings were chosen and used in classroom to deliver concepts in mathematics; the contexts chosen were appropriate to the concepts. The contexts chosen as problem situations were laden with a lot of facts to maintain the curiosity among the students; multimedias were used to present the contexts on screen using projector. The findings revealed that the *performance levels as well as process skills* of experimental group students exposed to IMIA was significantly better than that of their control group counterparts. It was observed that curiosity seemed to stimulate students to get involved in carrying the calculations for self; the challenge to invent for self was motivating factor towards engagement in process skills; repetition of procedure could be made interesting; the fact based contexts from other disciplines could trigger discussion and engagement in process aspects of concept development. There was the challenge of choosing the concept appropriate context from other discipline; this was the toughest task; then steering the discussion towards the concept was the crucial task for the teacher; Facts laden multimedias were likely divert students from the core concept. This was an attempt to break compartmentalization of disciplines and make mathematical process more important than product. ICT mediation was designed to accelerate the whole process efficiently.

Acknowledgement

Apart from the efforts of myself and my co-investigators, the success of any project depends largely on the encouragement and guidelines of many others. I take this opportunity to express my gratitude to the people who have been instrumental in the successful completion of this project. I would like to show my greatest appreciation to Prof. H. K. Senapaty and Prof. Nityanand Pradhan. I can't say thank you enough for their tremendous support and help. I feel motivated and encouraged every time I attend their meeting. Without their encouragement and guidance this project would not have materialized. I am highly indebted to Prof. L.K. Tiwari, Prof. J. Mandal, Prof. Ramesh Babu, Dr. K.A.S.S.V Kameswararao and Mr. Harish Prasad for their guidance and constant supervision as well as for providing necessary information regarding the project & also for their support in completing the project. I would like to extend my sincere thanks to Dr. P.K. Tripathy and Dr. N. Rohen Meitei for their immense support in successful completion of the project. My thanks and appreciations also go to my colleague in developing the project and people who have willingly helped me out with their abilities. I am highly indebted to the staff of D.M.S, Bhopal for their sincere and timely support.

The guidance and support received from all the members who contributed and who are contributing to this project, was vital for the success of the project. I am grateful for their constant support and help. After all I am highly indebted to PAC ERIC), NCERT for funding this project.

RAJA KISHORE NAYAK

Contents

1.0 Introduction

There is a tremendous need for researchers in mathematics education in developing countries to look at the actual life of urban workers, rural farmers and merchants and to identify the mathematics in daily life that is needed and used by people (Damerow, Dunkley, Nebres, & Werry, 1984). There is also a need to make connections between mathematics and other subjects of study (NCF 2005, p. 43). Much of the abstract discussion of educational goals overlooks the essential interrelatedness of low anxiety and high performance, and the need for teacher warmth if the climate to create is to be provided(White, 1969 p.15; Sears and Hilgard, 1964 p.197). Behaviorist epistemology focuses on intelligence, domains of objectives, levels of knowledge, and reinforcement. Constructivist epistemology assumes that learners construct their own knowledge on the basis of interaction with their environment (Fosnot, 1996). Vygotsky believed that social interaction, cultural tools, and activity shape individual development and learning, learners appropriate(internalize or take for themselves) the outcomes produced by working together (Woolfolk, 2008). With the recent introduction of computers in schools, educational computing and the emergence of learning through the understanding of cause-effect relationships and the interplay of variables, the teaching of mathematics will be suitably redesigned to bring it in line with modern technological devices (NPE 1992).

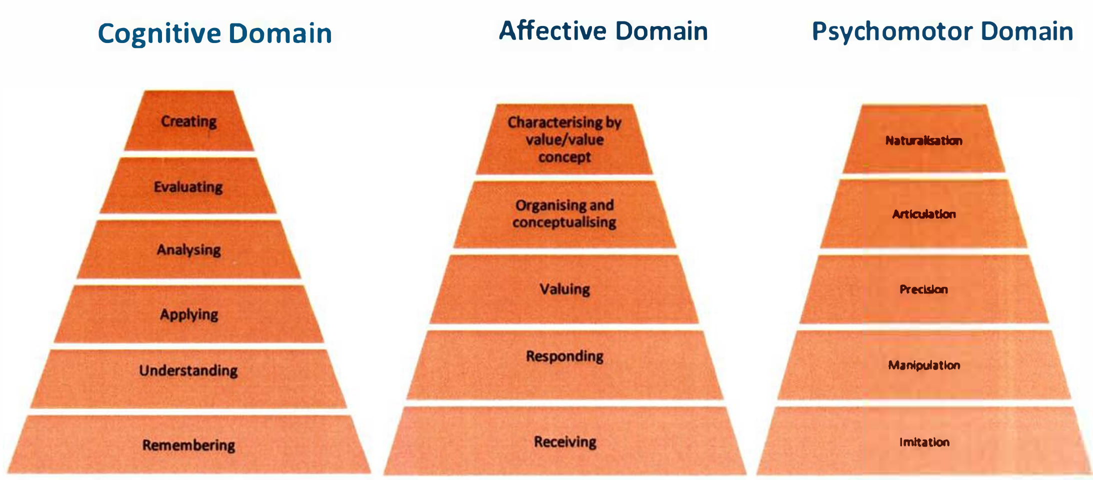


FIGURE 1: Different Domains of Learning

1.1 Need and Justification of the Study in the Contemporary Societal Context

It is the researcher's observation that the affective domain (receiving, responding, valuing, organizing and conceptualizing, characterizing by value or value concept) has not been given due importance in the present classroom practice. Also it is the belief of the researcher that successful and popular mathematics teachers naturally inculcate the affective domain components in their classroom transactions. NCF 2005 advocates constructivist pedagogy. Constructivist pedagogy is in developmental stage in India. Though NCERT is advocating constructivist approach of learning for more than a decade, still there seems to be no takers. Many teachers are of the belief that constructivist approach is too ideal to practise in regular classroom in India; it's good for experimental sake; it's not possible to cover the entire prescribed syllabus using this approach in limited classroom time in an academic calendar with lots of constraints. Though the philosophy of constructivist approach appeals many, constructivist practice is not percolating to the classrooms in India. Teachers are not very much optimistic about the effects of constructivist approach of learning on achievement in mathematics due to a variety reasons though they simultaneously appreciate the ideals of constructivist approach of learning; there is not much studies available to claim the ease of practice in real classroom in India; very few content areas of mathematics have been covered in most of the constructivist research in India; in most of the experiments duration of the exposure to experimental treatment is less. There is no study, at least to researcher's knowledge, that covers the mathematics course of an entire semester/year, and attempted to study the effect of constructivist approach of learning on achievement in mathematics amongst secondary school students. Mostly teachers complain of time constraints in regular classroom to practise constructivist approach; the challenge was how to translate the basic tenets of constructivist approach like social construction of knowledge, contextualisation of learning, collaboration, multiple representations of knowledge, and scaffolding into action in a period of thirty five minutes; it seems difficult on the part of a teacher without any external support to practise constructivist approach to impart mathematics learning in the present academic climate of school; ICT mediated tools can be a source of external support to a practising teacher in his/her attempt to promote constructivist approach of learning mathematics among secondary school students. There is a wide range of ICT tools available for educational purposes; these tools come with different prices, maintenance cost and demand different levels of expertise to handle; with time the cost of some ICT tools have come down drastically; there are also many free online sources providing a variety of multimedia materials related to secondary school mathematics. Looking at the recent interest shown and/or initiatives taken by different agencies associated with school education to provide basic ICT infrastructure, it was the curiosity of the researcher to use projector, laptop/PC, and the smart phone available with teacher as ICT tools to promote constructivist practice amongst secondary school students to learn mathematics; there are a variety of projectors and PC/laptop available at affordable prices; it was assumed by the researcher, taking into consideration the trend of development and economical cost of ICT tools, that either the schools possess these basic multipurpose ICT tools or an enthusiastic teacher can persuade the school administration to make these general ICT tools available; the present financial constraints of government schools may not afford to allow individual access to ICT tools, but one set of tools can be managed to the benefit of entire class for one period, this way most of the classes of entire school can benefit from one set of ICT tools described here; the basic idea was an average government/private school can afford these general ICT tools; these rough and tough ICT tools can also be used in any classroom with little bit of basic amenities; also, these mediational tools may suffice to promote constructivist practice among secondary school students. How can a teacher utilize affordable/commonly available ICT facilities to promote constructivist practice in mathematics learning among secondary school students? The researcher could not come across any research that studies the effect of ICT mediation to promote constructivist practice among secondary school students towards learning mathematics; though there are research studies to describe the effect of either constructivist approach or ICT on achievement in mathematics of secondary school students. The present research is an attempt to promote constructivist practice in Indian classroom setting with ICT mediation. The form of ICT mediation suggested here is widely available, bare minimum and cheapest in cost; this is basically to encourage teacher to adopt constructivist approach of learning in spite of financial and other infrastructure related constraints using affordable rough and tough basic multipurpose ICT tools. Furthermore, semiotic mediation plays an essential part in co-construction of knowledge (John-Steiner&Mahn,1996). In order to account for this social and participatory learning with a teacher or more informed peer, the concept of the zone of proximal development (ZPD) was developed by Vygotsky (1978). According to Vygotsky, social and individual functioning is mediated by semiotic mechanism-signs and psychological tools (Wertsch, 1991) as cited by Bozkurt(2017). Lerman (2000) as cited by Bozkurt(2017)also defined the ZPD as an instrument to examining individuals' contributions to the learning setting as well as the role of inter subjectivity in scaffolding participants.

The researcher has deliberately chosen basic forms of ICT mediated tools with the logic that if lower forms of ICT mediation can encourage constructivist practice, then advanced ICT mediated tools can certainly do. ICT mediated constructivist practice has been defined as an amalgamation of a variety of suitable content appropriate constructivist teaching – learning strategies like inquiry approach, cognitive apprenticeship, ICON(interpretation construction) model, problem based learning, and reciprocal teaching in a cooperative setting facilitated with projector, PC and smart phone.

1.2 Title of the Study/Project

Effect of ICT Mediated Interdisciplinary Approach of Learning Mathematics on Elementary Students

1.3 Conceptual Framework

Learning mathematics is still a challenge for many of our children in India. The bigger challenge is that even if we know a little bit of mathematics we fail miserably when we come across a practical daily life situation to apply. Interdisciplinary approach of learning mathematics may come to our rescue first by broadening the scope for application of mathematics to authentic real situations from our surroundings. Secondly, it builds confidence in our children by exposing them to interesting and useful facts. Thirdly, the boredom of mathematics classroom and watertight compartments go away to fill the classroom with live discussion, creation of multiple strategies to solve the immediate problem at hand, enthusiastic interaction with parents and other members of society etc. The guiding principle of NCF-2005 advocates enriching the curriculum to provide for overall development of children rather than remain textbook centric. To translate these ideal objectives, a potential pedagogical strategy called ***ICT Mediated Interdisciplinary Approach(IMIA)*** was identified by the investigator to stimulate reflective thinking among secondary school students. In IMIA, instead of designing the course to address specific "naïve conceptions," the instructor focuses on helping students construct appropriate concepts through authentic contexts from other disciplines and surrounding. Here students learn to correctly identify a physical system, represent it diagrammatically, and then apply the concept to the situation they are studying, their misconceptions tend to fall away and they get to know about the facts related to other disciplines; mathematics classroom gets filed with joy and pleasant contexts; even if somebody does not understand much mathematics still one does not get bored with and learns a lot of things from the texts of the given problem; since the problems are rich in facts and information not known to the child. The present study was designed to replace the artificial contexts of class 8 mathematics textbook with authentic contexts from other disciplines like physics, chemistry, civil engineering, biology, geology, geography, biodiversity, ecology, economics and surroundings of the child.

ICT mediation in the form of

I. **Characterising by value or value concept:** Two participants works displayed together on screen for self evaluation and critical judgement.

II. **Organising and Conceptualising:** Information rich problems with beautiful pictures were presented with the help of projector on screen to introduce the concepts; Multiple examples, 3 D images, back up strategies to suit the interest of participants with different learning styles, big screen, free from mispronounced reading and illegible writing by teacher helps them to organise and conceptualise the situation.

III. **Valuing:** Best works of their peers are displayed on screen and appreciated for the efforts they have put into. Best jobs are stored in best work folder for future reference. The related videos are made.

IV. **Responding:** The concept is presented through interactive contextual situation. The participants involuntarily respond to the situation.

V. **Receiving:** Peer group help, providing culturally sensitive description of problem situation in their mother tongue, bringing multiple perspective of the problem through scaffolding make them comfortable to receive the concept. Recording of students versions followed by scaffolding can help them receive the concept.

Variables:- Projector and smart phone mediated interdisciplinary approach of learning mathematics(treatment), Conventional method of teaching, Gender

Constructs:- practical quantitative skills, contents based on interdisciplinary approach, academic achievement, achievement in mathematics

1.4 Statement of the Problem

Can conventional mathematics classroom be changed to contribute to the learning of concepts from other subjects?

Can concepts related to other subjects be learned without hampering the learning of ongoing mathematical concepts? Does it enhance the mathematical understanding of the ongoing concept?

What are the mathematics concepts of class 8 those can be learnt through interdisciplinary approach?

Does the mediation of concepts from other subjects while learning mathematics help the students in understanding the involved mathematical process?

What is the effect of practicing interdisciplinary approach based mathematics using a projector, laptop and smart phone on interest and achievement of students?

1.5 Objectives of the Study/ Project

1. To compare the effect of Projector and Smart Phone mediated interdisciplinary approach of learning mathematics with traditional teaching strategy on achievement of *Process Skills* in mathematics of elementary students with reference to:

   (a) Perception of teachers

   (b) Perception of peers
2. To suggest a variety of ways to integrate concepts from other disciplines with mathematics learning using ICT mediated constructivist techniques

1.6 Hypotheses

H_i.1.1: The perception of teacher with regard to performance of learners taught through ICT mediated interdisciplinary approach and those taught through traditional approach vary significantly.

H_i.1.2.1: The perception of peers towards '*Meaning Making skills*' in respect of the group taught through ICT mediated interdisciplinary approach vary significantly from the perception of the peers of the group taught through traditional approach.

H_i.1.2.2: The perception of peers towards '*Drafting skills*' in respect of the group taught through ICT mediated interdisciplinary approach vary significantly from the perception of the peers of the group taught through traditional approach.

H_i.1.2.3: The perception of peers towards '*Reflecting skills*' in respect of the group taught through ICT mediated interdisciplinary approach vary significantly from the perception of the peers of the group taught through traditional approach.

1.7 Operational Definition

Traditional classroom setting: It contains writing board (blackboard or white board), textbook which each student is supposed to bring to classroom, students, teacher (experience of teacher), notebooks possessed by students, chart papers and models related to mathematics. Teacher mostly uses chalk and talk method to explain the concepts in mathematics. Occasionally students use boards to demonstrate their understanding or help others understand important concepts.

ICT mediated interdisciplinary approach: Using concept appropriate contents from across subjects like physics, chemistry, biology, geography, civil engineering, geology, civics, biodiversity, ecology as problem situations in mathematics for class 8 students. In the present context the ICT mediation was limited to the use of one LCD projector, laptop, smart phone, multimedia CDs, pen drive and loud speakers as hardware supplement to the existing traditional classroom setting. Among other additions were e-textbook, freely available readymade videos over internet on different mathematical concepts related to mathematics curriculum, videos created during ongoing class to demonstrate both good and bad examples of doing the assigned job, exposure to motivational videos at the beginning of each class, encouraging students to create e-materials in the form of power point presentations to facilitate their as well as other students learning in classroom and to take control of their own studies by resorting to best available source and learning at their own pace through access to repeat the multimedia material.

Achievement in *process skills* in mathematics: There are five process skills in hierarchical order like Emerging, Beginning, Developing, Expanding, and Proficient.; teacher placed each student in either of these levels based on their performance after intervention. Peers also assessed the engagement level of the students towards their *Meaning Making, Drafting, and Reflecting skills in three point scale* – Excellent, Good, and Needs improvement.

1.8 Literature Review

Voss et al. (1995) as cited by Bozkurt(2017) stated that the 'sociocultural revolution' has been recognized in the recent decade. By such a revolution, the emphasis on learning is not only through social interaction but also in out-of-school contexts (p.174). It is argued that people cannot comprehend the individual cognitive development in the absence of the social context in which the individual grows up (Gärdenfors, Johansson, 2005) as cited by Bozkurt(2017).

In Maturana's (1978) words as cited by Bozkurt(2017):"Knowledge implies interaction, and we cannot step out of our domain of interactions, which is closed. We live, therefore, in a domain of subject-dependent knowledge and subject-dependent reality... We literally create the world in which we live by living it." (pp. 17-18). Social constructivism is a philosophical stance which accepts that both social interaction and individual meaning making play pivotal and crucial parts in the learning of mathematics (Ernest, 1994; Ernest, 1998) as cited by Bozkurt(2017). Social constructivists, thus, consider the process of knowing as the essence of social interaction that leads to higher levels of reasoning and learning (O'Connor, 1998) as cited by Bozkurt(2017). In addition, the acquisition of intellectual skills is regarded as an active process involving others (Jones, Brader-Araje, 2002; von Glasersfeld, 1989) as cited by Bozkurt(2017). From the social constructivist point of view, culture and context has an essential role in understanding in order to construct knowledge through this understanding (Derry, 1999) as cited by Bozkurt(2017).

2.1 Methodology

It is the blue print of the entire research.

2.1.1 Research Design

The following plan was adopted to investigate the problem under study:

Posttest only Equivalent Group Design was followed.

R	**X**	**O_1**
R	**C**	**O_2**

O_1 and O_2 are post tests ; experimental and control groups are equated by random assignment of subjects to either group.

2.1.2 Population and Sample

Population: CBSE Secondary school students of M.P.

Sample: Two groups of class 8 students of DMS, Bhopal; Thirty-five students (24 boys and 11girls) made one sample and 36 students (23boys and 13girls) the other sample.

Sampling Technique: Random Sampling

2.1.3 Subjects

Subjects are in age group 13-15 years. Class 8 students were chosen as the population of interest for two reasons. First, because of a large variety of concepts in mathematics is introduced at this level as compared to other classes; the class 8 students are likely to have many misconceptions about basic mathematical skills needed to carry out complex real life calculations. Second, the eighth class marks the end of elementary mathematics; students need to get matured enough to make use of developmentally appropriate practices; and the treatment used in this study was designed in accordance with such practices.

2.1.4 Randomization

Students were randomly assigned to either experimental or control group; one of the group was randomly chosen to receive treatmemt.

2.1.5 Tools Used in the Study

I. Performance Assessment Rubric (constructed by researcher)

II. Engagement Assessment Rubric (constructed by researcher)

2.1.6 Statistical Techniques

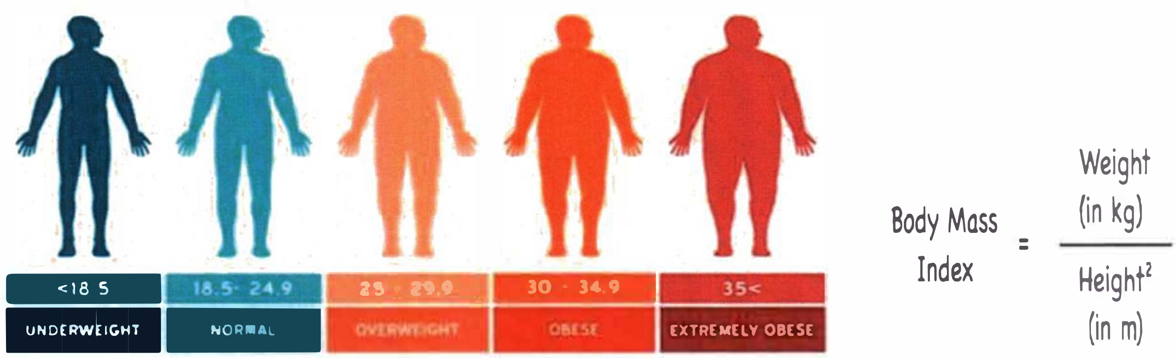
Chi Square test

SPSS 2016 version was used to analyse the data.

2.1.7 Treatment

Real and authentic situations were put before the students who were free to form their groups of four. The authentic situations included (but not limited to):

1.Body mass index (BMI) is categorised below .
Calculate the BMI of the students of your class and draw a pie chart.
Calculate the BMI of your family members.



Calculate the ideal healthy weight range of your family members.

2. A human body needs 2000 calories in a day. The calories we consume provide energy and nutrients that our bodies require. Three major sources of calories are Carbohydrates(grains, bread and pasta, fruits, vegetables, legumes and dairy products), Fats (dairy products, oil), and Proteins (nuts, pulses, meat)

FIGURE 2: BMI Chart

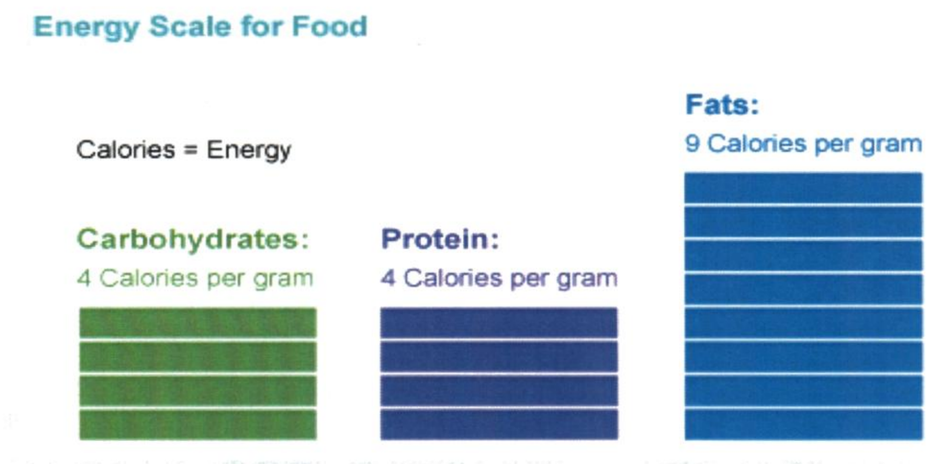


FIGURE 3: Energy Scale

55% calories from carbohydrates, 30% calories from Fats and 15% calories from protein. One burns 90 calories in 12 mins of physical activity. Now list your activities of yesterday and. Calculate the calories taken by you also find out the calories burnt. Decide if you fell short of calories or stored extra calories in the form of fat.

3. A **good** macronutrient ratio for a body is 25% protein , 55% carbs and 20% fat. In a meal of 350gm , how much protein (in gms) should your meal contain ?

4. Power consumption of ZERO WATT filament bulb is 15**w** with cost of ₹ 20, whereas an led bulb of 1w gives same light as zero watt bulb with cost of ₹ 80 under Ujjawal Yojana of Government

I replaced the five filament bulb from my home with led bulb, then how many units of electricity can be saved over 1 year. Assume that light is lit for 10 hours a day. 1 unit of electricity = 1000 watt hour.

FIGURE 4: Power Consumption and Saving Options

Hint :- Savings = 14 watt x 10 hour x 365 = 51100 watt hour =51100 Wh /1000 = 51.1kWh = 51.1 unit.

Money saved in one year = 51 x Rs. 8 = Rs. 408

Cost of five led bulbs = Rs.80 x 5 = Rs. 400

Cost of five filament bulb = Rs. 20 x 5 = Rs. 100

Extra money I spent towards purchasing led bulbs = Rs. 300

So, with this initiative I could EARN Rs. 108 in the first year itself; next year onwards I save at least Rs. 408 every year.

Your Problem: In case in your home you are using incandescent/fluorescent/ CFL, please think of replacing those items with LED lights. Design a plan to show how the replacement of lights at your home will help you reduce your bill.

5. Tiger is characterised as an endangered speices by the International Union for Conservation of Nature (IUCN). Fortunately for the first time the population of tigers have increased. Analyse the data given below and find out the % of world tiger population found in India . What is the rise in world tiger population since 2010.

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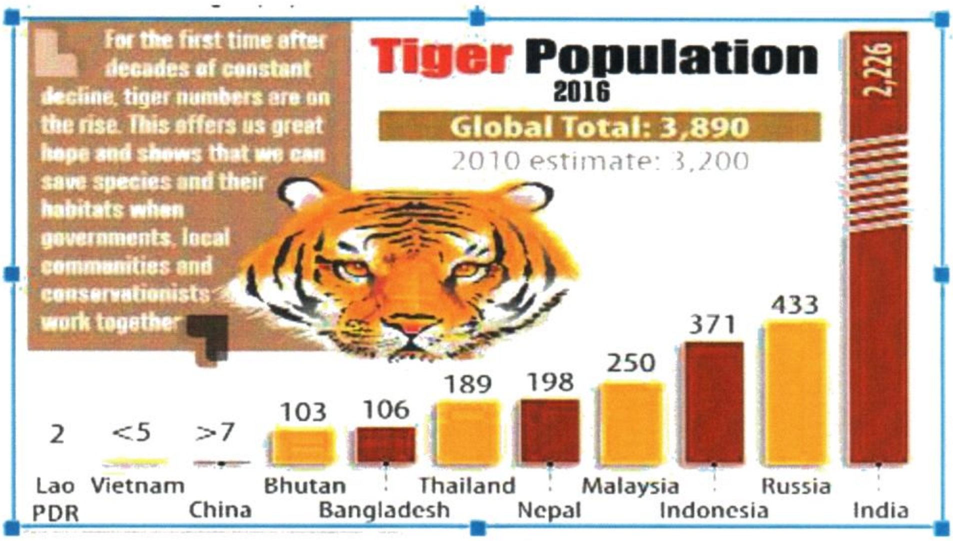


FIGURE 5: Ecological Conservation Efforts

6. The annual global production is around 80 million tonnes of poythene. It is a non-biodegradable material and harmful for the environment, liters the landscape also Sea animals indigest plastic bags mistaking them for food .In India most people take polythenes from greengrocers and avoid taking a big handbag to market. Find the amount (in kg) of polythene you bring to your home in a month { average weight of a polythene is 0.2gm . If the people of India (1.3 billion population) stop using poly bags and carry handbags while shopping. Calculate reduced production of polythene .

7. Amount of lighting required for a room depends on the size of the room and the purpose of the room. Intricate tasks require more lighting and just moving around the room requires much less light. The amount of light required in an area is defined as "LUX" level that is equal to lumens/area (lm/m^2). Below table gives a good idea of LUX level for various tasks:

TABLE 1

Tubelights:

Type	**Lumens (Brightness)**
T12 40W 4ft	2800
T8 36 W 4ft	2700
T5 28W 4ft	2750
T5 14W 2ft	1275

TABLE 2

Light Illumination

Activity	**Illumination** *(lux, lumen/m²)*
Public areas with dark surroundings	20 – 50
Simple orientation for short visits	50 – 100
Working areas where visual tasks are only occasionally performed	100 – 150
Warehouses, Homes, Theaters, Archives	150
Easy Office Work, Classes	250
Normal Office Work, PC Work, Study Library	500

TABLE 3

BULBS

Incandescent Watts	**CFL Watts**	**LED Watts**	**Lumens (Brightness)**
40	8 – 12	4 – 5	450
60	13 – 18	6 – 8	890
75 – 100	18 – 22	9 – 13	1210
100	23 – 30	16 – 20	1750
150	30 – 55	25 – 28	2780

If you have a room that is 10 ft x 10 ft (which is 9.29 m^2) and you want to do easy office work in the room, then find the amount of light required ? what watt tubelight or bulb can you use ?

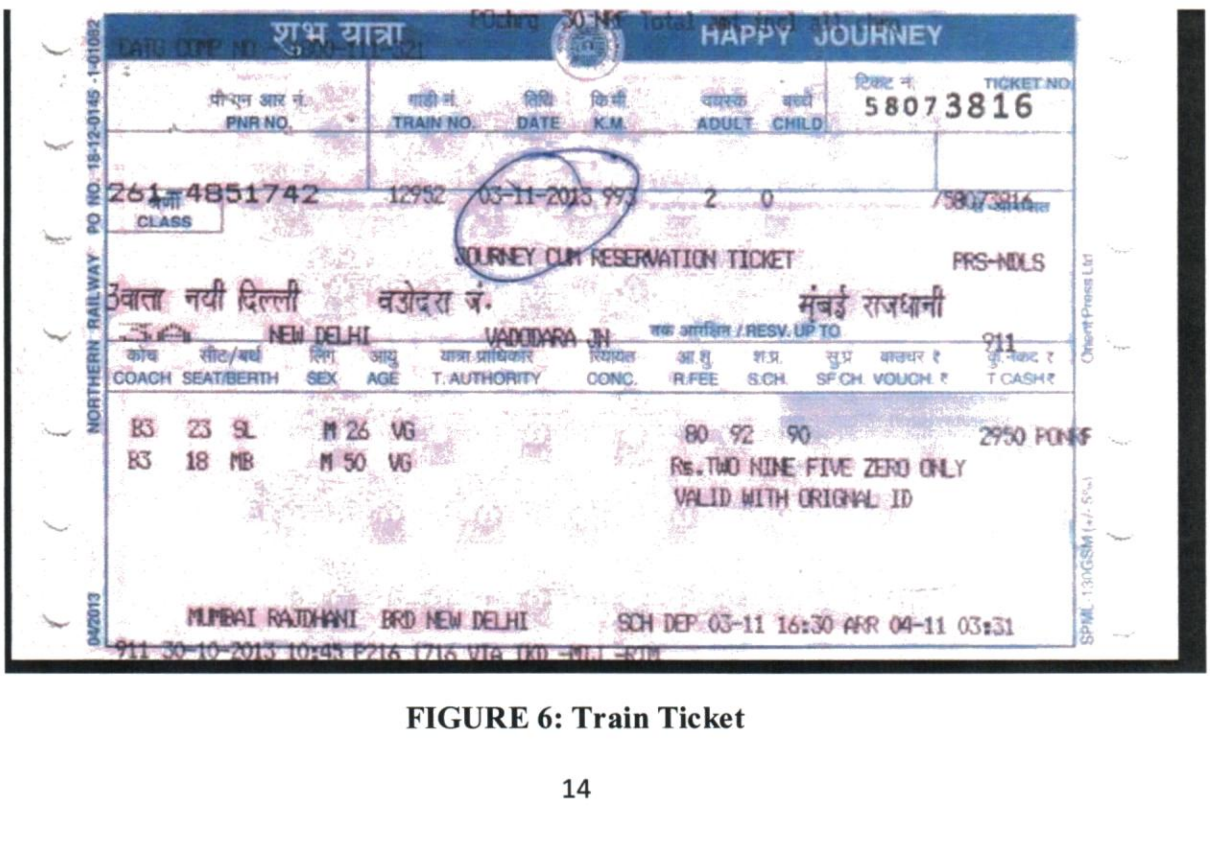
8. The respiratory rate in humans is measured when a person is at rest and involves counting the number of breaths for one minute by counting how many times the chest rises.Respiration rates may increase with fever, illness, or other medical conditions. Read the information given below and draw a frequency distribution graph age 0 to 30 Years .

TABLE 5

Resiration Rates

Group	Age	Breaths/min
Newborn to 6 weeks	Newborn to 6 weeks	30 - 60
Infant	6 weeks to 6 months	25 - 40
Toddler	1 to 3 years	20 - 30
Young Children	3 to 6 years	20 - 25
Older Children	10 to 14 years	15 - 20
Adults	Adults	12 - 20

9. Read the train ticket given below and find out the average speed of the train .


शुभ यात्रा HAPPY JOURNEY

NORTHERN RAILWAY

पीएनआर नं. PNR NO.	गाड़ी नं. TRAIN NO.	तिथि DATE	कि.मी. K.M.	वयस्क ADULT	बच्चे CHILD	टिकट नं. TICKET NO.
261-4851742	12952	03-11-2013	993	2	0	58073816

श्रेणी CLASS

JOURNEY CUM RESERVATION TICKET PRS-NDLS

नयी दिल्ली NEW DELHI — वडोदरा जं. VADODARA JN — मुंबई राजधानी — तक आरक्षित / RESV. UP TO 911

कोच COACH	सीट/बर्थ SEAT/BERTH		लिंग SEX	आयु AGE	यात्रा प्राधिकार T.AUTHORITY	रियायत CONC.	आ.शु R.FEE	श.प्र. S.CH.	सु.प्र SF.CH.	वाउचर ₹ VOUCH. ₹	कु. टिकट ₹ T.CASH ₹
B3	23	SL	M	26	VG		80	92	90		2950 PONRF
B3	18	MB	M	50	VG						

Rs.TWO NINE FIVE ZERO ONLY
VALID WITH ORIGNAL ID

MUMBAI RAJDHANI BRD NEW DELHI SCH DEP 03-11 16:30 ARR 04-11 03:31

911 30-10-2013 10:45 P216 1716

FIGURE 6: Train Ticket

10. Calculate the weight of your science text-book . Given the density of printing paper is $800 kg/m^3$

FRUITS	Serving	Iron	Calcium	Vitamin C	Fiber	Protein	FRUITS	Servings	Iron	Calcium	Vitamin C	Fiber	Protein
Guava	3.5 oz	1%	2%	371%	5g	3g	Fuji Apple	3.5oz.	1%	1%	8%	2g	0

FIGURE 7: Comparison of Nutrient Value of Fruits

By what % is Guava richer in vitamin c. which fruit will you advise people to eat if 1kg Apple cost is Rs 80 and 1kg guava costs Rs 20 and why ?

11. Find the volume of wood used in different section of Table Tennis board.

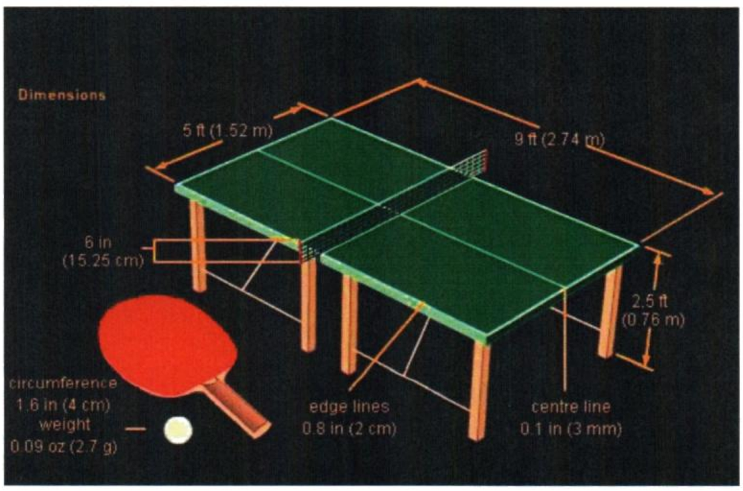


FIGURE 8: Table Tennis

12. Draw a labelled diagram of a badminton court. Calculate the area of different sections.

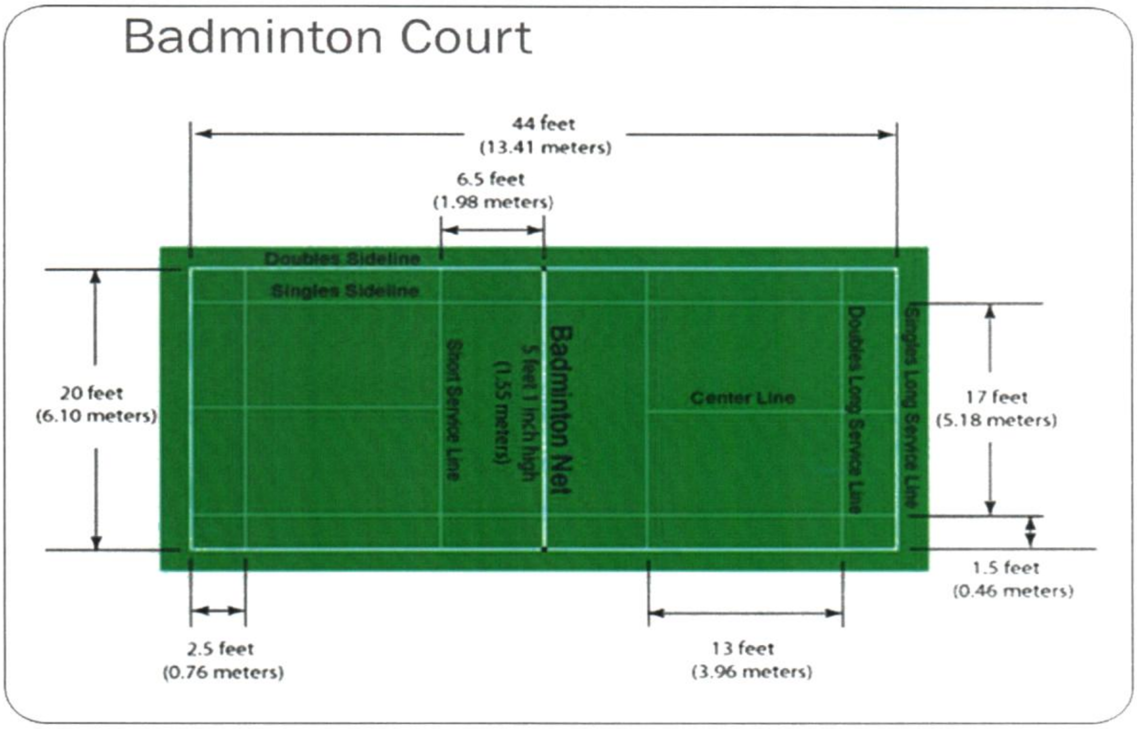


FIGURE 9: Badminton Court

How much area is needed for the entire court?

13. There are three 1.5 ton A.C. in my home with different star rating and in following table the comparison is given with 0 star A.C. whose power consumption is 2500 Watts/Hr.

TABLE 6

Comparison of AC

Star Rating	Power Consumption `(Watts/Hr.)	No. of watts saved/Hr.	No. of Units saved/8Hr.	Saving/day (Rs. 5/unit)
5 star	1490	1010	8.1	40.5
3 star	1566	934	7.5	37.5
2 star	1709	791	6.3	31.5

Find the average saving of electricity and money per month.

3.0 Results

Constructivist researchers often address the processes of interaction among individuals. They also focus on the specific contexts in which people live and work in order to understand the historical and cultural settings of the participants (Creswell, 2012, p. 37). The results pertaining to

1. The effect of ICT mediated interdisciplinary approach and traditional approach of learning mathematics: Teacher's Perception

2. The effect of ICT mediated interdisciplinary approach and traditional approach of learning mathematics: Peer Group Perception

are presented in the following sections.

3.1 Perception of Stakeholders

In order to assess the effect of ICT mediated interdisciplinary approach on learning achievement of students in mathematics, the perception of teacher was obtained along a rubric, Performance Assessment Rubric (APPENDIX A). The assessment of students made through a five point scale of the rubric (such as emerging, beginning, developing, expanding, and proficient) was analysed employing Chi Square test.

In order to assess the effect of ICT mediated interdisciplinary approach on learning achievement of students in mathematics, the perception of peers was obtained along a rubric, 'Engagement Assessment Rubric(EAR)' (APPENDIX B) for three components (such as meaning making, drafting, and reflecting skills of peers). The assessment of students made through a three point scale for each component of the rubric (such as Needs Improvement, Good, and Excellent meaning making / drafting / reflecting skills) was analysed employing three separate Chi Square tests.

3.2 Perception of Teacher towards Performance of Learners

H_i.1.1: The perception of teacher with regard to performance of learners taught through ICT mediated constructivist approach and those taught through traditional approach vary significantly.

Table 7 contains the results of Chi Square test that compares the relationship between the perception of teacher regarding students' attainment of different learning level and treatment using 'Performance Assessment Rubric (PAR)' (APPENDIX A).

TABLE 7

Chi Square Test: Significance of Relationship between Treatment and Attainment of Different Performance Levels

Group	N	*df*	Pearson Chi-Square	*p*
Experimental	35			
		4	18. 4*	0.001
Control	36			

*Chi Square Critical value for $df = 4$ at .05 level of significance is 9.49.

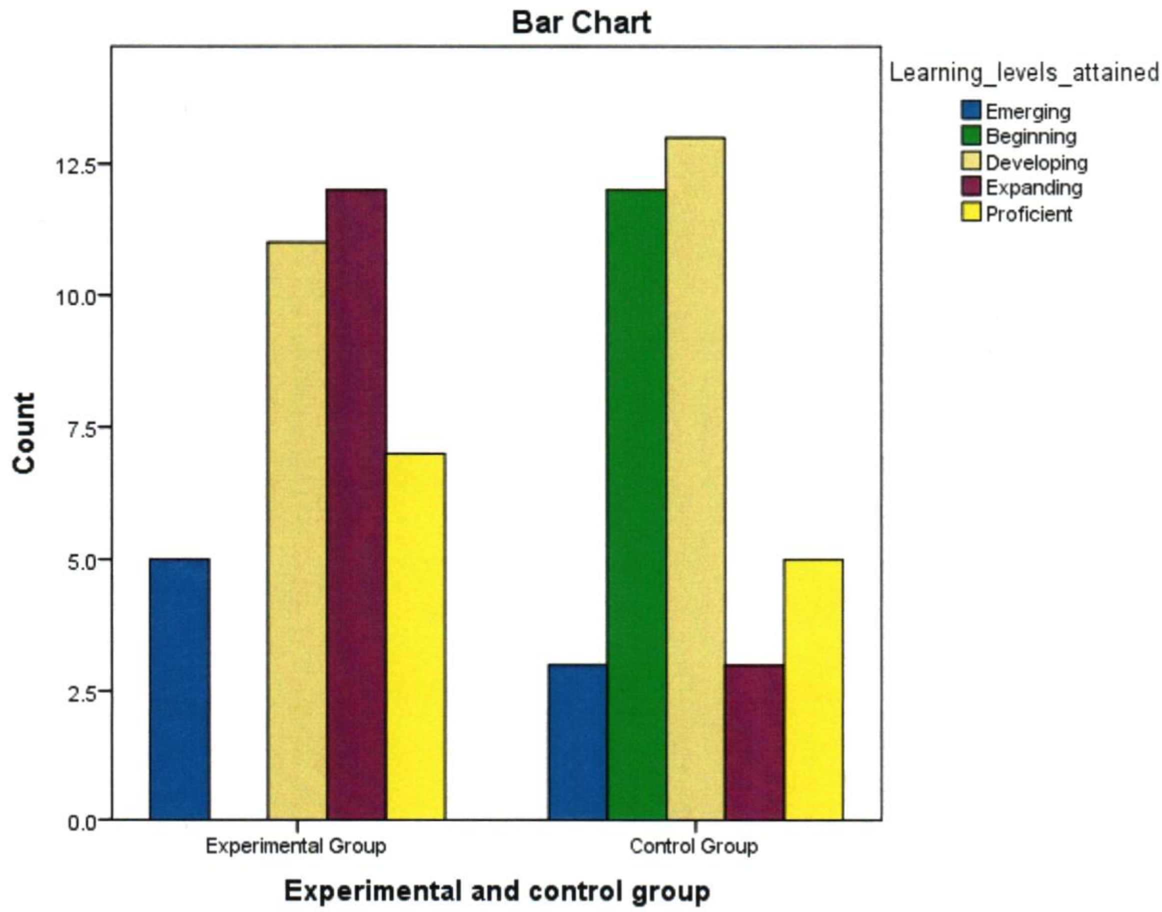


Figure 10: Distribution of Students Attaining Different Levels of Performance

The Chi Square value obtained is 18.4; $p < 0\ .05$. The null hypothesis may be rejected at the .05 level of significance. The test indicates that there is a significant relationship between treatment given and the number of students at different Learning Levels at 0.05 level of significance. The form of treatment is significantly related to the distribution pattern of students in different levels of learning. Chi square observations indicate that students exposed to ICT mediated reciprocal teaching strategy have attained better 'Learning Levels' than the students of control group (Figure 10).

ICT mediated interdisciplinary approach seems to push/drive students towards higher levels of learning in hierarchal order.

3.3 Perception of Peers towards Process Skills Attainment

Students were assessed by their peers in respect of their level of engagement in three different process skills such as meaning making, drafting, and reflecting; Engagement Assessment Rubric: Peers' Perception (Appendix B) gives the details of what constitutes each skill. Both groups (experimental and control) were compared in terms of number of students attaining different learning levels in the identified process skills.

3.3.1 Perception of Peers and Meaning Making Skills

H_i.1.2.1: The perception of peers towards '*meaning making skills*' in respect of the group taught through ICT mediated interdisciplinary approach vary significantly from the perception of the peers of the group taught through traditional approach.

Table 8 contains the results of Chi Square test that compares the relationship between the perception of peer regarding students' attainment of different levels of '*Meaning Making*' and '*Treatment*' using 'Engagement Assessment Rubric (EAR)' (Appendix B).

TABLE 8

Chi Square Test: Significance of Relationship between Treatment and Engagement of Students in 'Meaning Making' Skill

Group	N	*df*	Pearson Chi-Square	*P*
Experimental	**35**			
		2	**9.34***	**0.009**
Control	**36**			

*Chi Square Critical value for *df* = 2 at .05 level of significance is 5.99.

The Chi Square value obtained is 7.14; $p < 0.05$. The null hypothesis was rejected at the .05 level of significance. The test indicates that there is a significant relationship between the treatment given and the number of students at different levels of achievement in '*Meaning Making*' at .05 level of significance.

Chi square observations indicate that students exposed to ICT mediated reciprocal teaching strategy are at better position in '*Meaning Making*' than the students of control group(Figure 11).

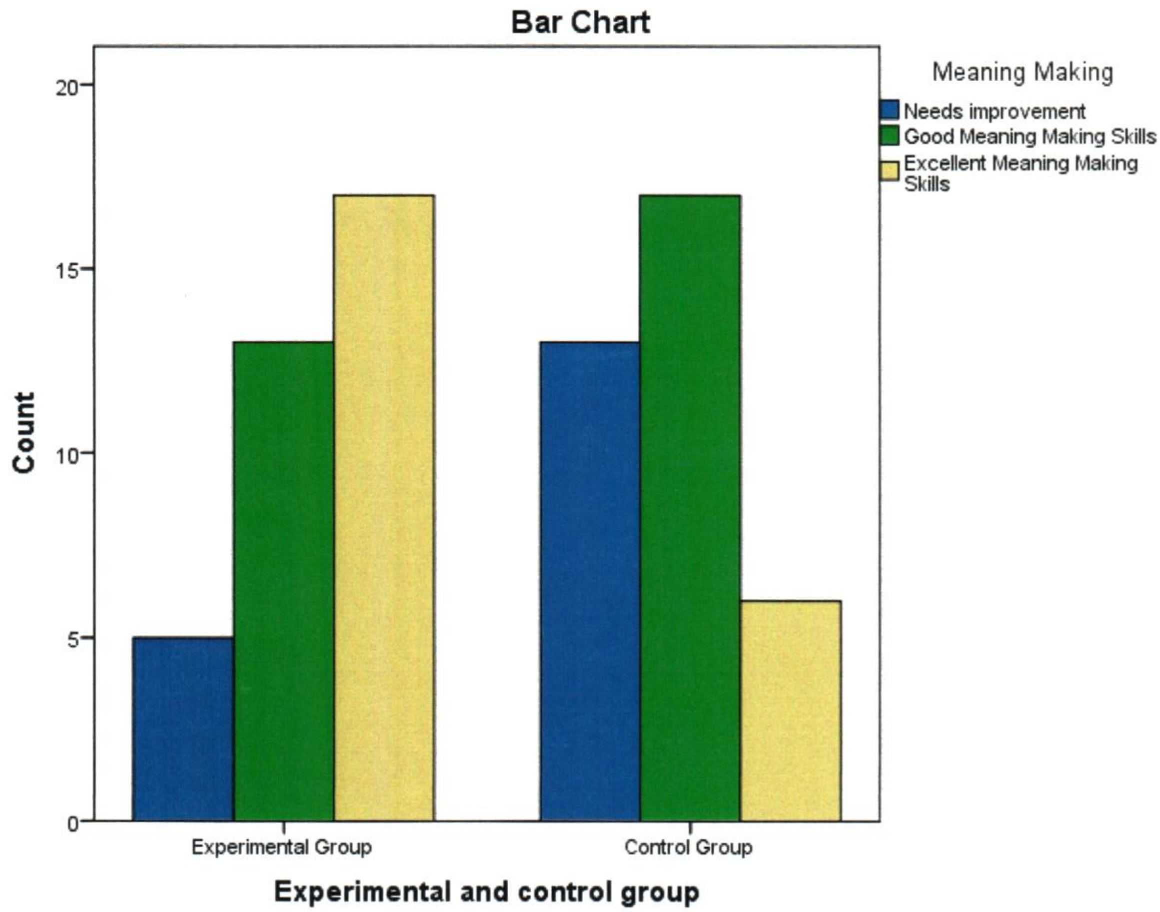


FIGURE 11: Distribution of Students Attaining Different Levels of 'Meaning Making' Skill

3.3.2 Perception of Peers and Drafting Skills

H$_i$.1.2.2: The perception of peers towards '*Drafting skills*' in respect of the group taught through ICT mediated interdisciplinary approach vary significantly from the perception of the peers of the group taught through traditional approach.

Table 9 contains the results of Chi Square test that compares the relationship between the perception of peer regarding students' attainment of different levels of *Drafting skills* and treatment using 'Engagement Assessment Rubric (EAR)' (Appendix B).

TABLE 9

Chi Square Test: Significance of Relationship between Treatment and Engagement of Students in 'Drafting' Skill

Group	N	*df*	Pearson Chi-Square	*p*
Experimental	**35**			
		2	**8.75***	**0.013**
Control	**36**			

*Chi Square Critical value for *df* = 2 at .05 level of significance is 5.99.

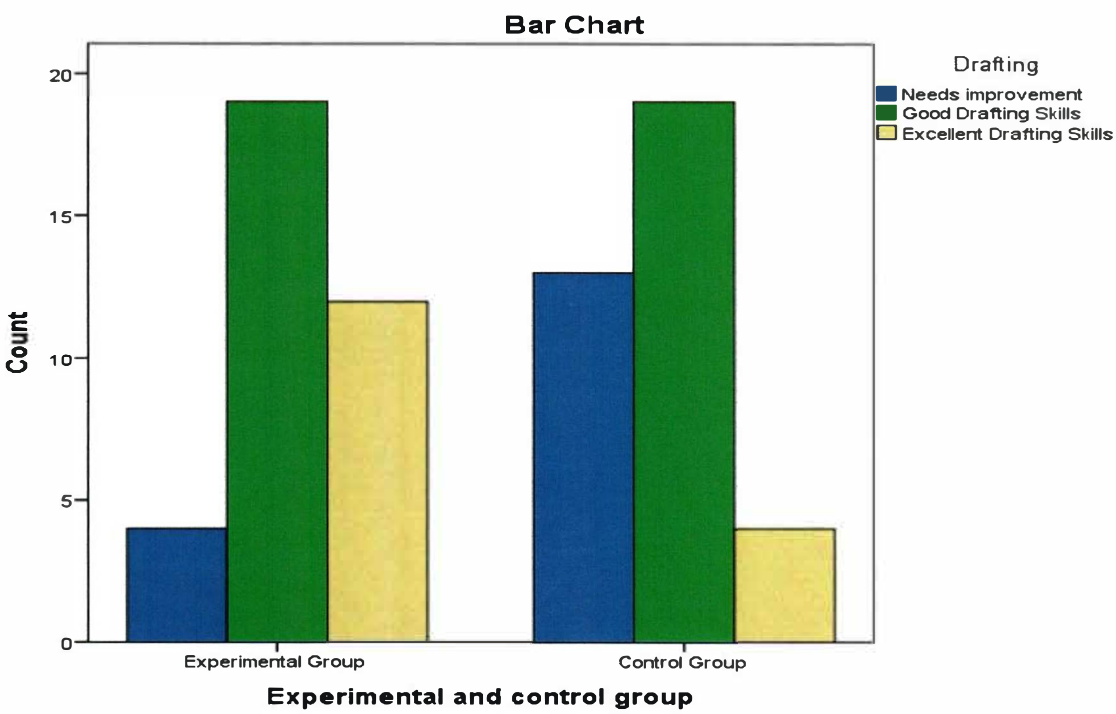


FIGURE 12: Distribution of Students Attaining Different Levels of 'Drafting' Skills

The Chi Square value obtained is 8.75; $p < 0.05$. The null hypothesis was rejected at the .05 level of significance. The test indicated that there is a significant relationship between treatment given and the number of students at different levels of achievement in '*Drafting*' *skills* at .05 level of significance.

Chi square observations indicate that students exposed to ICT mediated interdisciplinary approach are at better position in '*Drafting*' than the students of control group (Figure 12).

3.3.3 Perception of Peers and Reflecting Skills

Hi.1.2.3: The perception of peers towards '*Reflecting skills*' in respect of the group taught through ICT mediated interdisciplinary approach vary significantly from the perception of the peers of the group taught through traditional approach.

Table 10 contains the results of Chi Square test that compares the relationship between the perception of peer regarding students' attainment of different levels of *Reflecting skills* and treatment using 'Engagement Assessment Rubric (EAR): Peers' Perception' (Appendix B). The Chi Square value obtained is 8.1; $p < 0.05$. The null hypothesis was rejected at the .05 level of significance. The test indicated that there is a significant relationship between the treatment given and the number of students at different levels of achievement in '*Reflecting*' *skills* at .05 level of significance.

Table 10

Chi Square Test: Significance of Relationship between Treatment and Engagement of Students in 'Reflecting' skill

Group	N	*df*	Pearson Chi-Square	*P*
Experimental	**35**			
		2	**8.1***	**0.017**
Control	**36**			

*Chi Square Critical value for $df = 2$ at .05 level of significance is 5.99.

Chi square observations indicate that students exposed to ICT mediated reciprocal teaching strategy are at better position in '*Reflecting skills*' than the students of control group(Figure 13).

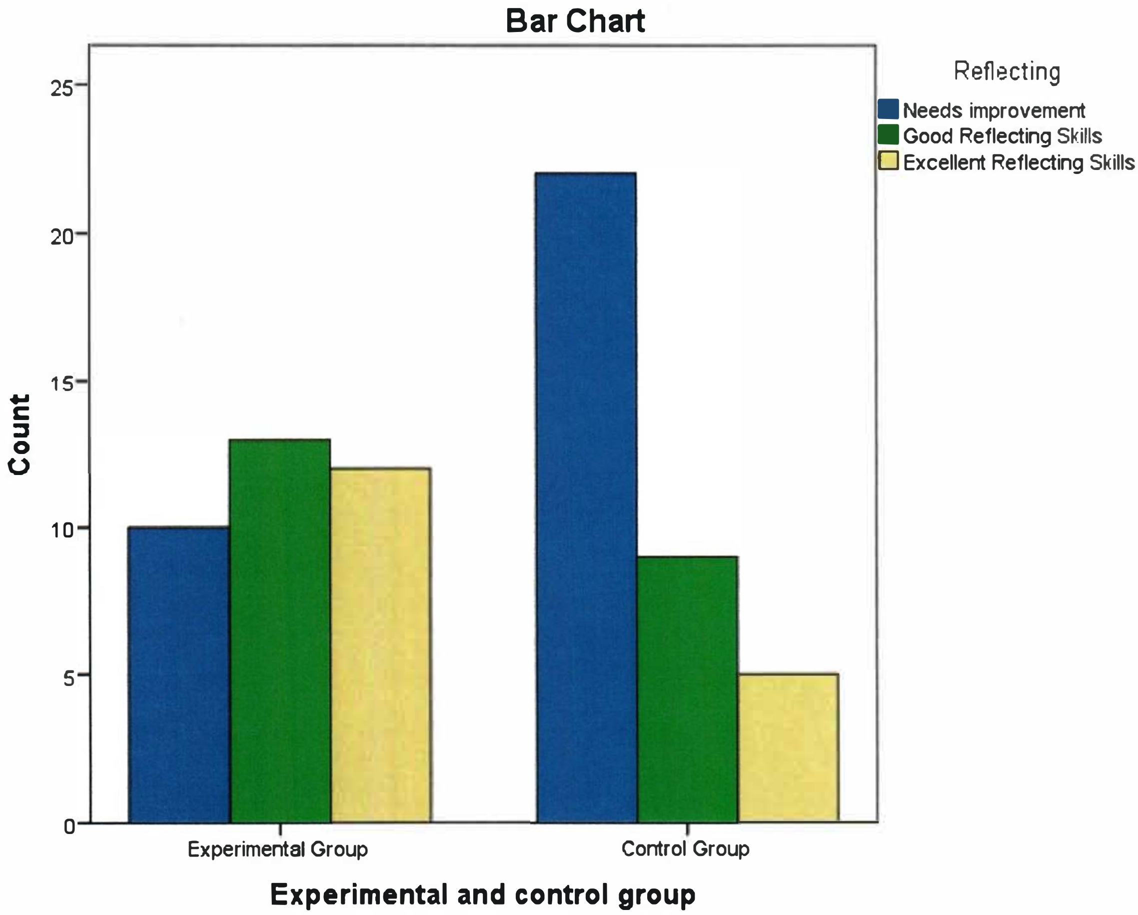


Figure 13: Distribution of Students Attaining Different Levels of Reflecting Skill

3.4 Discussion

3.4.1 IMIA and Teacher's Perception

There was a significant relationship between treatment given and the number of students at different Learning Levels at 0.05 level of significance. The form of treatment is significantly related to the distribution pattern of students in different levels of learning. Chi square observations indicated that students exposed to ICT mediated reciprocal teaching strategy have attained better 'Learning Levels' than the students of control group (Figure 10). ICT mediated interdisciplinary approach seems to push/drive students towards higher levels of learning in hierarchal order.

What general components of IMIA led to the above finding…

(i)In addition, the pictorial representation via technology-based environment was easy and convenient for the teacher to manipulate and demonstrate the mathematical concepts. In the other hand, the technology assisted in allowing students in the experimental class to interact with the mathematical concepts in novel ways.

(ii) It promoted the students in the experimental class to develop calculation abilities through manipulating the model shortcut live representation of calculation. Therefore, there are several benefits for teaching and learning mathematics concepts via a technology-based learning environment: explaining diagrams and figures from textbook by computer could be done more easily, visual representations could attract the students' attention, and overlapping and separating the graphs could be more efficiently and conveniently accomplished by the computer.

How they could achieve better Performance Levels through IMIA…

(i) The authentic situations used as problem contexts – contextualization kept on motivating the students. There was more vibrant discussion among students; they were more receptive. They were enthusiastically involved in calculations; there was some surprise element for them in each calculation; they were coming with certain mind bugling facts. For example they did not know so many facts about tiger population. There was challenge for them. Each question was individualized. For example, while calculating BMI, they were enthusiastic enough to find their own BMI and compare with other; these tedious calculations they won't have done for them; but out of curiosity they calculated the BMI for their entire family to assess the status of family member's health. If interesting contexts can be chosen to introduce concepts in mathematics, then certainly engagement levels of students can be expected to rise. The challenge for the teacher is choosing concept appropriate contexts from across disciplines; as this is comparatively emerging idea, teachers need to put personal experience to gather relevant context.

(ii) Searching for relevant contexts in efficient way is possible through ICT; presentation of contexts in the form of multimedia helps in catching the attention of students to the desired concept.

(iii) Live discussion in the correct direction is very much required; teacher was needed to steer the discussion so as to help students get the correct concept; discussions were needed to be restricted so as not to deviate from the crux of the concept.

(iv) These visual imagery along with mathematical calculations strengthened the concepts related to other disciplines.

3.4.2 IMIA and Peers' Perception

There are three main components of the Engagement Assessment Rubric (EAR): Meaning Making, Drafting, and Reflecting. Three separate Chi Square tests were carried to test the significance of difference between the groups in terms of their attainment levels in respective component of engagement.

What made the difference in meaning making skills of students…

The attainment levels of students of experimental and control group in 'meaning making' skill was determined using the EAR. The students of experimental and control group were categorized into three groups on the basis of their attainment levels in 'Meaning Making' skill using the EAR. The test indicated that there is a significant relationship between treatment given and the number of students attaining different levels of engagement in '*Meaning Making*' at .05 level of significance. Chi square observations indicate that students exposed to ICT mediated reciprocal teaching strategy are at better position in '*Meaning Making*' than the students of control group.

This finding can be seen in the light of:

(i) The word by word reading of the content of mathematics text book by expert students at beginning followed by weak students improved the reading standard of the entire class. The display of on screen display of textbook using projector helped the entire class concentrate on the reading and simultaneous meaning making.

(ii) Students facing difficulty in pronouncing certain words could benefit from collective reading using onscreen display.

(iii) Few students possessed excellent skills of negotiating the meaning of problem form the given text; these skills could percolate in the entire class.

(iv) Students recorded their reading and meaning of the text at home using features of smart phone; the textbook was displayed and the related audio was played simultaneously. Students could improve their meaning deciphering skills in a number of ways like commenting on the description given by their peer, listening skills, pronunciation skills, translating in local tongue, developing heuristics to decipher meaning of text etc.

(v) Recording with smart phone their reading and inferring meaning became a hobby for few students; they loved to share their meaning making techniques with others using social platforms like Whats App; this complex task of helping children in meaning making could be simplified with the interference of more able peers. The engagement beyond school hours was inspiration for the entire class; students could discover the educational aspects of social media and features of smart phone.

(vi) Students were enthusiastic and happy to know that their way of interpreting the problem was accepted and praised in class.

(vii)These actions could strengthen the reciprocal teaching strategies; it added to the existing techniques of reciprocal teaching.

(viii)Teacher was not unnecessarily burdened; students were enthusiastically trying to read, highlight and infer meaning out of the text; all these were happening as a group; a major part of teacher's responsibility to introduce the text book to class was shared with the more able peers. Since most of the students were more likely to skip the contents of textbook prior to exercises, this ICT mediated reciprocal teaching strategy could induce the compulsory habit of reading and meaning making.The observations are supported by psychological theory of White (1969, p.36) i.e. imitation occurs, therefore, when an observer is directly rewarded by an external stimulation, or vicariously, from internal stimulation resulting from prior emotional conditioning. The ICT mediated story telling techniques and playing the media clips prepared by peers, probably, induced internal stimulation from emotional conditioning. Most of the advantages of the ICT mediation with interdisciplinary approach could not be availed in traditional set up.

What made the difference in 'Drafting skills' of students…

The attainment levels of students of experimental and control group in 'Drafting' skill was determined using the EAR. The students of experimental and control group were categorized into three groups on the basis of their attainment levels in 'Drafting' skill using the EAR. A Chi Square Test for independent samples was carried to test the significance of relationship between treatment and engagement of students in 'Drafting' skill; The test indicated that there is a significant relationship between treatment given and the number of students attaining different levels of engagement in '*Drafting' skills* at .05 level of significance. Chi square observations indicated that students exposed to ICT mediated reciprocal teaching strategy are at better position in '*Drafting*' than the students of control group.

This finding can be seen in the light of:

(i) Students also come with certain procedures they have learnt elsewhere ; they feel proud to demonstrate and claim that their way of doing the task is better than the procedure followed in class. The entire class listened to such claims; advantages and disadvantages of the procedure was discussed at length. When the procedure was found better than the procedure followed in class, then the concerned student was praised for his/her effort in class. When the student's procedure was recognized and declared better than the procedure of class, then the student was found to be more engaged in the helping others understand the procedure. This act of identifying, praising, and sharing responsibility with more able peer did help the teacher in reaching out to students in need.

(ii)Repeated exposure to similar procedures helped students strengthen their calculation abilities; ICT mediated information rich contexts helped students enjoy the repetitive work; the curiosity of students kept them driving the repetitive job. Under normal circumstances these repetitions seem boring.

What made the difference in 'Reflecting skills' of students…

The attainment levels of students of experimental and control group in 'Reflecting' skill was determined using the EAR. The students of experimental and control group were categorized into three groups on the basis of their attainment levels in 'Reflecting' skill using the EAR. A Chi Square Test for independent samples was carried to test the significance of relationship between treatment and engagement of students in 'Reflecting' skill; The test indicated that there is a significant relationship between treatment given and the number of students attaining different levels of engagement in '*Reflecting' skills* at .05 level of significance. Chi square observations indicate that students exposed to ICT mediated reciprocal teaching strategy are at better position in '*Reflecting*' than the students of control group.

This finding can be seen in the light of:

(i). Students perceived certain ways of doing calculations/solving a complex problem better than the way teacher explains; even if sometimes an easier path was shown, students needed time to accommodate the new trick; teacher respected their way of doing; they were free to help their friends with their method of doing; in the process of explaining the trick to their friend, they revised the topic again and again.

(ii) When their peer commented on their strategy, they turn more reflective to the strategy followed by teacher than their own strategy; this helps them in choosing the easier strategy; also this process involved intense debate and discussion among fellow group mates to prove how one method was superior to the other; the class together, as a whole decided the advantages of one method over other.

ICT mediation helped students to become more reflective; it promoted reflective practice in class room.

(iii) At times students came with their own heuristics to crack the problem. When students were provided with opportunities to demonstrate their heuristics, the entire class benefitted. Simple classroom strategies like 'anybody with better idea can come forward to board and demonstrate it to everybody' could bring innovative strategies to the fore front.

The presence of a screen and multiple ways of content delivery styles motivated students to present their own style of understanding. There were several videos explaining the same concept; students used to decide which video helped them understand the concept in easier way. They started judging the explaining and presentation skills of their classmates as well as experts.

4.0 Conclusion

The findings revealed that the *performance levels as well as process skills* of experimental group students exposed to IMIA was significantly better than that of their control group counterparts. It was observed that curiosity seemed to stimulate students to get involved in carrying the calculations for self; the challenge to invent for self was motivating factor towards engagement in process skills; repetition of procedure could be made interesting; the fact based contexts from other disciplines could trigger discussion and engagement in process aspects of concept development. There was the challenge of choosing the concept appropriate context from other discipline; this was the toughest task; then steering the discussion towards the concept was the crucial task for the teacher; Facts laden multimedias were likely divert students from the core concept. This was an attempt to break compartmentalization of disciplines and make mathematical process more important than product. ICT mediation was designed to accelerate the whole process efficiently.

5.0 Suggestions for Further Studies

1. Research needs to be carried to develop concept appropriate authentic contextual situations from across disciplines as problems in mathematics.

2. Effect of interdisciplinary approach on achievement in traditional annual examinations needs thorough investigation.

3. Effect of interdisciplinary approach on attitude towards mathematics needs to be studied.

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Appendix A

Table 11

Performance Assessment Rubric (PAR): Teacher's Perception

5 **Proficient**	1. Discovers alternate ways to solve. 2. Finds short cut tricks and explain others precisely. 3. Takes up more challenging problems from other sources. 4. Relates the current concept with others.
4 **Expanding**	1. Solves and properly presents on note book problems similar to examples with little bit deviation/twist 2. Helps others understand the concept. 3. Asks for more similar problems. 4. Creates new/ difficult problems for self by replacing the textbook question with authentic situation.
3 **Developing**	1. Reads the question with appropriate pause to make meaning in local tongue. 2. High lights important parts of question and relates these to formula. 3. Identifies and writes on note book what is given and what part of formula is missing. 4. Takes action similar to solved example/ successfully repeats the procedure of just solved example.
2 **Beginning**	1. Begins to answer simple probing questions related to topic. 2. Tries to recall/identify the new terms and their meaning 3. Tries to complete the writing part on note book. 4. Seeks help from friends/teacher to understand.
1 **Emerging**	1. Vaguely connects to the new idea. 2. Needs more examples to understand the similarities and differences between earlier concept and new concept. 3. Scrabbles miserably on note book. 4. Looks baffled when asked simple probing questions.

Table 5 Perfromance Assessment Rubric (PAR): Assessment (Data Collection Tool)

Concept/Status	Group	Emerging		Beginning		Developing		Expanding		Proficient	
		I	II	I	II	I	II	I	II	I	II
1.	E										
	C										
2.	E										
	C										
3.	E										
	C										
4.	E										
	C										
5.	E										
	C										
6.	E										
	C										
7.	E										
	C										
8.	E										
	C										
9.	E										
	C										
10.	E										
	C										
Average over 10 concepts	E										
	C										

I* represents number of students at the particular level at the time of introducing the concept; II* represents number of students at the particular level at the end of introducing the concept; E for experimental group and C for control group.

APPENDIX B

TABLE 12

Engagement Assessment Rubric (EAR): Peers' Perception

1 **Meaning making**	1. **Reading the problem word by word** 2. **Underlining important parts of problem** 3. **Explaining what is given and what needs to be done in the problem in local tongue** 4. **Relating the present problem to already solved example**
2 **Drafting**	5. **Noting the given conditions on notebook** 6. **Visualising the sequence of operation/action to be taken** 7. **Writing on the note book the solution statements** 8. **Carrying the calculations in boxes near the solution steps**
3 **Reflecting**	9. **Referring worked out examples/ solutions of others projected on screen/peer criticism/suggestion to improve understanding/ own representation of solution on notebook** 10. **Evaluating peer's notebook**

A – Excellent; B – Good; C – Needs improvement

TABLE 13

Analysis of Student Initiative

Student/ Involvement	**Inquisitiveness**	**Task Completion**	**Peer Tutoring**	**Peer Evaluation**	**Total**

*A – More than desired level; B – Satisfactory; C – Needs improvement

TABLE 14

Engagement Assessment Rubric (EAR): Peer's Perception (Individual Tool)

Concept/Ability	1. Reading the problem word by word	2. Underlining important parts of problem	3. Explaining what is given and what needs to be done in the problem in local tongue	4. Relating the present problem to already solved	5. Noting the given conditions on notebook	6. Visualising the sequence of operation/action to be	7. Writing on the note book the solution statements	8. Carrying the calculations in boxes near the	9. Referring worked out examples/ solutions of others projected on screen/peer criticism/suggestion to improve understanding/	10. Evaluating peer's notebook	Total Score
1. A*	3	3	3	2	3	2	2	3	2	2	25
2. B	3	3	2	2	2	2	2	3	3	2	24
3. C	3	2	2	3	2	2	3	2	3	2	25
4. D	3	2	2	1	3	3	3	3	3	2	25
5. E	3	2	2	2	2	2	2	3	3	2	23
6. F	3	3	3	3	3	3	3	2	3	2	28
7. G	3	2	3	2	2	2	3	3	3	2	25
8. H	3	3	3	1	3	3	2	2	2	2	24
9. I	3	3	2	2	2	2	2	3	2	2	23
10. J	3	3	1	1	2	2	3	3	3	2	23
Total	30	26	23	19	24	23	25	27	28	20	245

*A,B,C, ...represent the names of concepts covered in the class; students mention their observation about the status of their group mates with respect to the assessed concept.

TABLE 15

Engagement Assessment Rubric (EAR) Elaborated Version: Peer Assessment (Group Data Collection Tool)

Name/Ability***	1. Reading the problem word by word	2. Underlining important parts of problem	3. Explaining what is given and what needs to be done in the problem in local tongue	4. Relating the present problem to already solved example	5. Noting the given conditions on notebook	6. Visualising the sequence of operation/action to be taken	7. Writing on the note book the solution statements	8. Carrying the calculations in boxes near the solution steps	9. Referring worked out examples/ solutions of others projected on screen/peer criticism/suggestion to improve understanding/ own representation of solution on notebook	10. Evaluating peer's notebook	Total
1. A	30	26	23	19	24	23	25	27	28	20	245
2. B											
3. C											
4. D											
5. E											
6. F											
7. G											
8. H											
9. I											
10. J											
11. K											
12. L											

***Rubric to assess the engagement status of entire class by clubbing the peer assessment

TABLE 16

Engagement Assessment Rubric (EAR) Compressed Version: Peer Assessment (Group Data Collection Tool)

Name/Ability***	Meaning making	Drafting	Reflecting	Total Score
1. A				
2. B				
3. C				
4. D				
5. E				
6. F				
7. G				
8. H				
9. I				
10. J				
11. K				
12. L				
13. M				
14. N				
15. O				
16. P				
17. Q				
18. R				
19. S				
20. T				
21. U				
22. V				
23. W				
24. X				
25. Y				