

TALES BUILDING CONCEPTS: A CONSTRUCTIVIST APPROACH TO TEACHING-LEARNING SCIENCE

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The present study is intended to use indigenous pedagogy of story telling as strategy of teaching and learning of science concepts beyond classroom and beyond textbook. The concepts related to properties of light and working of lenses have been selected under this research study. Target population was all learners of Classes VII and IX. The study was completed in three phases. In the first phase the methodological framework to pursue was identified, in the second phase interventions were provided as a story. In the third phase post intervention assessment was carried out. The research findings depict that story telling is an effective way in learning of science concepts and may be used by the teachers for effective teaching-learning process for augmentation of learning.

Introduction

After the National Curriculum Framework (NCF) 2005, when nationwide orientations about the National Focus Group Position Papers and the post NCF teaching-learning resources and strategies were built and the syllabus and textbooks developed and published by the National Council of Educational Research and Training, New Delhi, were in public domain, NCF had already completed its journey of half a decade in national educational arena for almost 5-6 years (NCERT, 2006b, 2006c, 2006d). The necessity to dig deep and perceive actual feedback about the penetration of implementation and recommendations of the

current curriculum was deeply felt. The idea was utilised as an opportunity to the authors to get first-hand experience of curriculum transaction in any one of the rural schools of India for a period of three months. In this endeavour the researchers had visited rural school Sarvodaya Kanya Vidyalaya, Aaya Nagar in Delhi. The very objective behind this pilot visit was to interact directly with learners and gain first-hand experience as a teacher for deep sited understanding of school system, learners, teachers and learning environment in view of the implementation of recommendations of NCF 2005. The visit was crucial in framing the research framework and developing the structure to collect the feedback about the post NCF books, teaching process and problems in implementing the

recommendations of NCF 2005.

NCF 2005 emerged as a major paradigm shift from teacher centric to learner centric pedagogy. This very shift changed the pattern of textbook writing and brought shifts in the pedagogical impartation of the teaching-learning processes. The syllabus based on NCF 2005 is theme based and translated textbooks in science have reflected six basic criteria of validity as suggested by NCF 2005 and Focus Group Position Paper in Teaching Science, 2006.

The focus of the present study is on establishing content and cognitive validity of NCF 2005. Content and cognitive validity of content is reviewed and emphasised by Field (2011). It was observed that some of the optical instruments, such as, microscope and telescope are used by children as toys even before the upper primary classes and, moreover, the microscope is a necessity to learn many science concepts right from Classes VII, VIII, IX and beyond. But children do not learn the principle of working of these instruments before a much later stage. Even about the lenses they learn very little in secondary classes. This leaves unattended queries in the mind of the child. The kindled curiosity remains unanswered and the child carries doubts in perception of the instruments as: "How we see big using microscope?" and "How can we see galaxy comfortably using telescope?" and also "How are the rainbows formed in the sky?". Thus the process of construction of knowledge is constrained by the lack of perception building and becomes the reason they do not get the opportunity to think out of box and bring innovations.

NCF 2005 also recommends to learn

beyond textbook and beyond the four walls of the classroom to break the monotony of learning in the classroom. The researchers interacted with the learners at upper primary and secondary stages, where they found that learners were clueless about "How light passes through one medium to another impacting visibility of objects to our eyes"? or "How the rainbow appeared during rain under sunlight?" These led the researchers to think of multiple ways in which the learners could get acquainted with the unseen and untold magic of lenses. The aspiration of the researchers to impart the properties of the lenses was not restrained to the functioning of the microscope and telescope but the visible perception of the natural phenomenon of lights.

While engaging learners of Classes VII and IX under multi-grade environment, it became obvious to researchers that all students are using optical instruments but lacked knowledge regarding the awareness of their working. This belief was further reinforced when during the interaction the basic questions remained unanswered in the classroom.

Microscope is an important instrument to understand the intricacies of many concepts related to life which is a part of the curriculum at upper primary and secondary stage learners. It is essential for performing activities to observe under the microscope without which the very objective of learner centric approach cannot be fulfilled as recommended in the present curriculum (NCF 2005). Besides, learners also visited Nehru Planetarium as a part of field visit which is considered as learning beyond classroom (NCERT, 2006), But during the visit also the intricacies and the nuances of the telescope remained unexplained. The questions and the instruments pertained to

the properties of light but not addressed in the curriculum at upper primary stage.

Thus the present study was conceptualised with the research questions that what were the most exciting and innovative ways to impart science lessons to students and what would be their perception towards the basic concepts of science and towards science itself and the results of the intervention that was conducted by the researchers.

After detailed review of literature, story telling as a technique was chosen as the method of intervention and to acquaint them with three major concepts:

- (i) There are combination of lenses in the microscope that works for magnifying the image of an object.
- (ii) There are a combination of lenses in the telescope that works for looking at the farther objects clearer.
- (iii) When light passes from air through water droplet it separates into its component colours.

Research Methodology

Research Design

The research design was chosen to be a

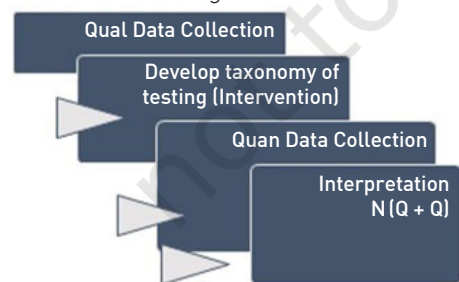


Fig 1: Exploratory design by Creswell and Clark (2007)

- (i) Focus group discussion with learners of Class VII and IX.
- (ii) Interventions.
- (iii) Post-intervention Assessment.

Sample and Sampling Technique

The sample of the study was of 128 students—66 students were from Class VII and 62 students were from Class IX of the same in which the pilot study was conducted. All the students were following English as a medium of instruction.

The technique of sampling was purposive as the school was a government school from a rural region and where the permission of intervention was granted.

Tools of Data Collection

- Focus group discussion with learners of Classes VII and IX:

The research question was identified during the interaction of researcher (FGD) with learners. The FGD as in conversation between the researcher and learners in the classroom situation is given below.

Researcher: So, how in the microscope do we observe a large size of the object?

Learners: No answer from learners

Researcher: Do you find that you can see the farther objects are nearer through telescope?

Learners: Yes.

Researcher: How is it possible through telescope?

Learners: No answer from learners

Researcher: Have you seen the rainbow?

Learners: Yes

Researcher: How many colours are there in a rainbow?

Learners: Seven colours, VIBGYOR

Researcher: Could you count colours in a rainbow?

Few voices of Learners in chorus: Yes Ma'am.

Researcher: Does the beam of light get separated in seven colours of VIBGYOR?

Learners: No answer, but some whispering voices came out as "Kaise hota hai?" (How does it form?)

Thus, the objective of the research study was identified as following:

How to improve learners' perception of following concepts of science?

- (i) Combination of lenses in the microscope works for magnifying the image of an object.
- (ii) Combination of lenses in the telescope works for looking at farther objects clearer.
- (iii) When light passes from air through water droplets it separates into its component colours.

• Interventions

Storytelling is an effective pedagogical tool at primary stage (Mohd Roslan and Roslinawati, 2008; Coulter et al; 2007). The science teacher was involved for providing intervention in the class through a story planned by the researchers. After the quarterly test it was the right time and collectively decided by the science teacher and researcher to provide interventions. Teacher wrote a letter to students—

Dear Students,

You had quarterly test last week. Today you had the last paper of the quarterly test. You prepared and worked hard for this test. I feel today you should play outdoors, enjoy and relax. This is a letter from my side to all of you which contains a story entitled: 'An Unusual Journey through Light from Microworld to Galaxy', please go through it definitely before bed and let me know how did you like it? And what all is there in the story? We will discuss in the class tomorrow.

Story is as under—

That was the last day of school before winter vacation. Vani was very happy as all the students of Classes VIII and IX had a trip for five days to Delhi. Teacher informed all students that all of them will by bus travel as their small village near Alwar in Rajasthan is approximately 150 km from Delhi. Teacher also informed them that they will visit National Science Centre, Nehru Planetarium, National Museum, Red Fort, etc. in Delhi.

They had to leave next morning at eight o'clock. Having so many preparations in mind for the trip, Vani eagerly came home and happily informed her grandmother about all the preparations for the visit. Grandmother was sitting on the small cot below the drumstick tree, where sunlight was sieving and passing through the clumps of leaves and branches of the tree and touching her body. It was pleasing to sit under the tree. It was neither too hot nor too cold. Vani laid herself down on the bed and put her head in the lap of grandma and started chit-chatting about her planned visit to Delhi. She was very excited and happy about the trip. Grandma smiled at her and instructed her to take some precautions and all preparedness when she will be out on tour.

Soon Vani dozed off. She started day dreaming. Vani saw herself flying in the sky. She had two very big wings. She was flying sometimes below clouds and sometimes above clouds. She was enjoying herself. Everything looked small from the height. Oh, look at my school, it is looking so tiny and roads of my village are looking very clear and nice, she thought and smiled. She flapped her wings and flew higher, above the clouds. Oh, my goodness! It is so amazing. See, how the things look so different from here.

Everything was so wonderful that she did not want to blink her eyes even for a moment. Suddenly she saw a water droplet from a cloud jumped and trapped it between both of her eyelids. The temperature at that height was very low but just above zero degree. Thus, the water droplet trapped between the two eyelids was not exactly ice but it was at the transition to be converted to ice.

"Oh, what is this?", she exclaimed with joy! "Do the things look little bigger?" Yes....., she thought for a moment. Things in the sky were really looking bigger to her. In the meantime, one smaller droplet flew in and stuck parallel to the earlier droplet (Fig 2). All objects were magnified and she could even see spores of microbes present in air. She could connect the structure of microbes and their spores she had seen in a science magazine while going through an article on aeroallergens. She could recall that once senior students of her school were putting the slide layered with petroleum jelly on pollen collector located in herbal garden in the school and pollens present in the air were sticking to the slide. The slide was later removed and observed under the microscope.

Vani could recollect things which she had seen in her day-to-day life. She saw her

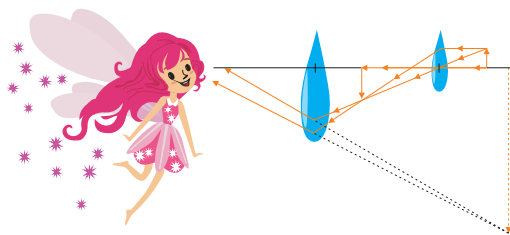


Fig 2: Usage of lens in microscope

grandpapa using convex lens while reading newspaper to magnify letters. She was remembering activities while interacting with her school mates in the science club. She also remembered that few days back she went to physics laboratory in her school and used lenses in various activities with her senior students. She also tried to understand the working of single lens and combination of lenses. By this time she realised that the water droplets are working as convex lenses and combination of lenses are working as microscope in this case.

Vani was enjoying the journey. She was so happy to experience a sense of learning. She could visualize how the combination of lenses actually increased the magnification and the given object looked larger in size. This was actually the principle on which microscope works. She could see the fine and coarse adjustment of microscope automatically working in the air. Sometimes both the droplets working as lens were coming close to each other and sometimes they were going far from each other.

She touched her eyes for that small droplet working as lens. She felt cold and the lens got misstructured. Oh, it is spoiled, she thought.

But of course, it was momentary. She flapped her wings. She could see the sunlight. She was flying below the cloud over the piece of land where it was raining. She surprisingly saw rainbow. Her eyes glared as she could see beautiful colours of VIBGYOR. She thought of beautiful colours, violet, indigo, blue, green, yellow, orange and red. Is she really looking at? She tried to catch them while flying. Mystery of how the rainbow colours appeared was still unresolved in her mind. She could connect it with an activity shown to them on National Science Day that the light is going through water droplets where refraction is taking place resulting in separation of seven colours of visible light. She was enjoying a lot. It wasn't the end of her journey. She was flying high and feeling so lucky having wings like fairy tales she had read many times in the story books.

She looked at the sky. It was infinite. Again, a small water droplet in the form of a lens got fixed near both her eyelids and again bigger lenses parallel to them (Fig 3). "It seems dusk time" she mumbled. She was diving in the sky looking at the galaxy. Apparently the combination of lens is working as telescope now. She was excited with the experience.

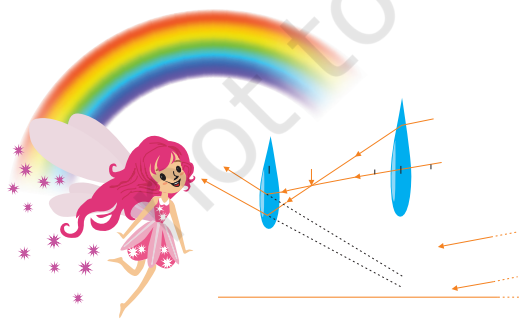


Fig 3: Usage of lens in telescope

Suddenly, with a gust of wind the drumstick tree moved slowly and there was gradient in the sunlight falling on her eyes. It was sunlight continuously alternating with the shadow on her eyes. Due to this she suddenly became conscious after a beautiful dream. She smiled and thought "Oh! it was a dream", she heard voice of *her grandma* "Vani.....Vani get up...".

• Post Intervention Assessment

Since the intervention was provided by involving science teacher to the students and in the form of a story so that necessary concepts regarding working of lens and property of light may be learnt by children of Classes VII and IX, the assessment was also done in an interesting and natural way.

Assessment Tool: There were six assessment items in the tool — It included three activity based items, one multiple choice (MCQ) one very short answer type and one open ended type of item to be carried out as fun activity without any pressure of assessment. The items were as follows:

- (i) Activity based: Students were provided with coloured pencils to make sketches of rainbows on the paper individually. The colours they had chosen in making the sketch of rainbow were assessed for the colour chosen by them and the serial of the colour they have used in their sketches was examined.
- (ii) Under which of the following conditions perception of rainbow was formed in Vani's eyes?
 1. When sunlight travelled through air to water to air while reaching Vani's eyes.

2. When sunlight passed only through water while reaching Vani's eyes.
 3. When sunlight passed only through air while reaching Vani's eyes.
 4. It was just vacuum, there was no medium between Vani's eye and sunlight in the story.
- (iii) Activity based: Two different convex lenses were given to learners and facilitated to move up and down one above the other over a given object.
- The question was asked— "Which fraction of the story is related to this activity?"
- (iv) Very short answer type: Can we relate lens with microscope and telescope? State your answer in 'Yes' or 'No'.
- (v) Open ended: Any guess what makes microscope to magnify an object?
- (vi) Activity based: Learners were provided with the toy telescope and facilitated to observe all lenses of telescope and allowed to see through both the sides.
- The question was asked that "What makes telescope to see farther objects clearer?"

• Tools of Data Analysis

Content analysis and thematic analysis was done and frequency was deciphered as per discussions and answers to form opinion in affirmations and negation. The very usage of content and thematic analysis for such purposes is supported by Vaismoradi *et. al.* (2013).

Interpretation and Discussion

Results of the study in three phases is presented as under —

Focus Group Discussion

In this phase the research question was identified during the interaction with learners in the class. However, they were using both microscope, telescope and all were aware and had seen rainbows a number of times during rains. But they were not knowing the simple fact of this natural phenomena.

Intervention

Next day when the researcher reached the combined Classes of VII and IX and asked if they have read the story which their teacher had given to them the day before, all learners discussed the story thoroughly in the class. All had smiles on their faces and eyes were full of curiosity. There was general acceptance that the paper was well liked.

Post Intervention Assessment

In this phase an assessment was carried out using six assessment items. Results of frequency of per cent learners' attainment of concepts for each item is presented in Table 1 for meeting the objectives of the study.

Table 1
Frequency of learners' attainment of concepts against each item (%)

Item no.	Frequency of learners' attainment of concepts (%)	
	Class VII	Class IX
1	100	100
2	92.5	100
3	100	100
4	100	100
5	100	100
6	100	100

Qualitative Analysis

- (i) First item was designed in such a way that there was no stress of any examination and started with a fun activity of sketching. All learners could make the sketch and serially arrange the VIBGYOR colours.
- (ii) Second item was a multiple choice. Questions in which students were asked to tick mark in one correct option out of four options in the answer sheet. All 62 students of Class IX could answer correctly and 61 out of 66 students of Class VII could answer correctly by putting tick mark for first option. In other words total achievement score for this item for Class IX students was 100 per cent and of Class VII students was 92.5 per cent. Rest of the 7.5 per cent students of Class VII opted for either third option or fourth option. That means even after reading the story they could not see clouds as water and few not even air. These 7.5 per cent learners need different intervention to understand the concept. They may have a kinaesthetic learning style and not of the aural and visual style.
- (iii) All learners of Classes VII and IX could answer this item correctly. That means all learners could relate the lenses with the water droplets in the story working as lens.
- (iv) For item IV, all learners agreed and could relate lens with both devices microscope as well as telescope.
- (v) In response to item V, some learners wrote lenses and some wrote

combination of lenses. Over all, they know that it is effect of lens that magnify the object.

- (vi) For this item again learners could relate lenses with the working of telescope.

Thus the answer to the second research question pertained to an overall success in learning through aural-visual style achieving the content and cognitive validity (Field, 2011, 2013) of the NCF 2005. Thus, activity enhanced learning with storytelling technique and narration method may be considered as an effective tool in realising the components of the philosophy of constructivism.

Storytelling is an indigenous pedagogy and play a big role in learning (Wilson, 2004; Aikenhead, 2001). Storytelling by grannies had been contributing since long in over all personality development of children. The same has been employed in the present study as an intervention strategy to learn the concepts that have not been addressed in science textbook at upper primary stage and with very little preliminary information at secondary stage. Thus, teachers also lack training, conceptualisation and creativity to take up the concept in the classroom and not beyond classroom learning. But it is necessary to have a general idea about the functioning of these devices at upper primary and secondary stages. In the present study, the story telling has come out as a successful pedagogy to learn the concepts of science and may be used by the teachers as beyond textbook and beyond classroom teaching-learning process as supported by Freisen (1999) who has discussed the power of traditional story as pedagogical tools.

Recommendations

This study justifies broad outlook in view of NCF 2005. It builds on learning as free from any fixed boundaries and it should not hamper the understanding of a concept. In the present study, if we see, that the child at birth itself is involuntarily exposed to light through eyes, which is one of the sense organs in human body and can make many observations in the natural world because it can sense light. But keeping in view the content and cognitive validity, the very concepts of working of lenses is spontaneously missing to be a part of upper primary syllabus, but the devices became a part of it to address learner centred pedagogy in the classroom. The basic idea of lens has been given in the *Textbook of Science* for Class IX. However, teachers may take up such concepts in the class as project activities under “learning beyond classroom” and “learning beyond textbook” as per the recommendations of NCF 2005. So that the concept of ‘learning beyond classroom’ and ‘learning beyond textbook’ as recommended by NCF 2005 may be implemented for improving teaching and learning of science in the classroom.

Syllabus and textbook developers may think of bringing such concepts at early stages of school education to which involuntarily a child is exposed to, since birth, as seeds to unveil a very small concept behind which a big world is waiting to be unveiled. This may provide learners to further think into, even in their unconscious minds continuously and naturally construct the knowledge.

The study may be helpful while revising the textbooks of science at upper primary and secondary stages and textbook developers would take into account the concerns raised in the study while developing the textbooks.

Also, storytelling has come out as a powerful pedagogical tool in the present study for learning of some concepts of science, it is recommended that this obliterated indigenous pedagogy may be a part of science teacher capacity building programmes and it is the need of the hour and to bring it back into the live classrooms in teaching learning process again. So that this indigenous pedagogy of learning at the verge of disappearance may be saved.

References

- AIKENHEAD, G. 2001. Integrating Western and Aboriginal science; Cross-cultural Science Teaching. *Research in Science Education*. Vol. 33. pp. 337-355.
- CRESWELL, JOHN W AND VICKY L. PLANO CLARK. 2007. *Designing and Conducting Mixed Methods Research*. SAGE Publications, Thousand Oaks, Calif. 2007.
- COULTER C, C. MICHAEL AND L. POYNOR. 2007. Storytelling as Pedagogy: An Unexpected Outcome of Narrative Inquiry. *Curriculum Inquiry*. Vol. 37 No. 2. pp. 103 – 122.
- FIELD, J. 2011. Cognitive validity, in Taylor, L (Ed) Examining Speaking: Research and Practice in Assessing Second Language Speaking, *Studies in Language Testing*. Vol. 30, Cambridge: UCLES/ Cambridge University.

- FIELD, J. 2013. Cognitive Validity, *In: Examining Listening*, Chapter 1, Cambridge University Press. pp. 77-151.
- FREISEN, J.W. 1999. The Functions of Legends as a Teaching Tool in Pre-colonial First Nations' Societies. *Interchange*. Vol. 30. No. 3. pp. 305-322.
- MOHD ROSLAN, ROSLINAWATI. 2008. The Use of Stories and Storytelling in Primary Science Teaching and Learning. *Studies in Education*. Vol. 12. pp. 79-89.
- NATIONAL COUNCIL OF EDUCATIONAL RESEARCH AND TRAINING. 2005. *National Curriculum Framework 2005*. New Delhi.
- . 2006a. *Position Paper: National Focus Group on the Teaching of Science*. New Delhi.
- . 2006b. *Syllabus for Secondary and Higher Secondary Stages*. NCERT, New Delhi.
- . 2006c. *Textbook of Science for Class VII*. NCERT, New Delhi.
- . 2006d. *Textbook of Science for Class IX*. NCERT, New Delhi.
- VAISMORADI, MOJTABA AND TURUNEN, HANNELE AND TERESE BONDAS. 2013. Content Analysis and Thematic Analysis: Implications for Conducting a Qualitative Descriptive Study. *Nursing and Health Sciences*. Vol. 15, No. 3.
- WILSON, S.S. 2004. Research as Ceremony: Articulating an Indigenous research paradigm. Unpublished doctoral dissertation, Monash University-Australia.