Blending Science with Fun Activities, Toys, and Games for Conceptual Understanding

An Experimental Study

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Abstract

Quality of education is one of the most important concerns for a developing nation particularly with reference to science education. In this research study, fun activities, games, and toys were blended with different concept of science for generating interest and conceptual clarity in teaching-learning process of science at the Upper Primary Stage. The study was conducted with 116 learners organised during COVID 19 *pandemic. It was observed that teaching-learning in science with games, activities and toys was significant in bringing change in better conceptual understanding of the subject and nurtured interest towards it. Such friendly and inclusive teaching-learning environment also resulted into active participation of learners. The study also opened new horizons in teaching-learning process for teachers as well. Traditional games, which have faded away from children's life with time, were included in the study to bring them back in practice. Thus, such collaboration resulted in stimulating better conceptual understanding with development of social skills and behavioral aspects.*

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Introduction

Science has prime importance as a subject in school curriculum as it helps learners to develop problem solving and critical thinking skills by actively exploring the environment (Rubini et al., 2019; Syafii and Yasin, 2013). The Right of Children to Free and Compulsory Education (RTE) Act, 2009 (MHRD, Government of India) in one of its clauses throws light on a curriculum which should ensure all round development of the child and makes learning process child-friendly and child-centric (Department of Higher Education, Ministry of Education, Government of India).

Science is being considered as one of the most demanding subjects at the school level. Researches indicate that there is a declining interest in learners towards learning science (Akram et al., 2017; Barmby et al., 2008; Guvercin et al., 2010; Kirikkaya, 2011; Potvin and Hasni, 2014; Turner and Ireson, 2009). The traditional teaching-learning methods like chalk and talk, reading out the chapter in class, etc., emphasise more on memorisation and recitation, which ultimately leads to rote learning without any deep understanding of the concepts and restricting learning to the classroom only. This also lacks interaction among teachers and learners and makes teaching-learning process monotonous and dull. Apart from this, in the present education system, learners' knowledge and understanding are usually analysed through their academic achievement.

Therefore, it is welcome to implement innovative pedagogical practices for making the teaching-learning process interesting, interactive and child-centric. The new approach should be filled with fun, which will create interest of learners towards the subject, encourages interaction amongst learners, thus being child-friendly and child-centric. National Curriculum Framework 2005 (National Council of Educational Research and Training, 2005) recommends that the child should be engaged in learning the principles of science through hands-on experiences as it will merge theoretical concepts with practical knowledge. This increases conceptual understanding, enhance cognitive growth, and helps in retention of scientific concepts for a longer time. According to Levin, students learnt and memorised new things more easily through toys and activities (Levin, 1974). As mentioned in NCF 2005, "when I was a child, I had the freedom to make my own toys out of trifles and create my own games from imagination" (Rabindranath Tagore).

Review of Literature

Various studies have reported integration of activities and games with teaching-learning process to be more effective for learners in developing higher thinking skills, conceptual understanding of the subject, cognition (knowledge, understanding and application based), interest and collaborative skills but majority of them were done in an inclusive set

up (D'souza, 2017; Vlachopoulos and Makri , 2017; Zarzari, Z. S., 2014.; Al-Tarawneh, 2016; Khan et al., 2012; Shri Krishna Mishra et al., 2013; Trajkovik et al., 2018; Trevino et al., 2016; Varzani, 2013). Majority of the studies exclusively focused on electronic toys, but in one study, STEM teaching-learning process was integrated with non-electronic toys (Thananuwong, 2015) but it does not answer our research question. In the present era, integration of digital technology with education is more effective than traditional ways of teaching (Meenakshi, 2013; Sangra and Gonzalez-Sanmamed, 2016) as it enhances social skills and problem-solving skills (Kirikkaya et al., 2010), involves active participation of learners with greater interest and conceptual understanding (Papastergiou, 2009). However, a major drawback of such digital games is lack of face-to-face interaction of learners' with teachers and even amongst learners.

Keeping this in view, the Department of Education in Science and Mathematics (DESM), NCERT, New Delhi has published two handbooks, one for the Upper Primary Stage (National Council of Educational Research and Training, 2018) and other for the Secondary Stage (National Council of Educational Research and Training, 2020). The handbook for the Upper Primary Stage suggests fun activities, games (outdoor and indoor) and toys as an educational tool for the teaching-learning process of science. Games, activities and toys which are considered as means of entertainment, were used as educational tools in which the pedagogical content was weaved. Low cost or no cost materials were used to perform activities suggested in the handbook which otherwise is expensive in digital games. The unique feature of the handbook is to club scientific concepts with traditional games (*stappu*, *pithu*, etc.) and bring them back to the limelight, which is lost nowadays due to digital games. Teaching-learning through such process sharpens learners' cognitive capabilities, deepens understanding of the subject, creates alertness, enhances observation power, listening skills and critical thinking skills, develops team spirit amongst learners due to their active participation and interaction with other learners and thus augment overall development of the learner.

The India Toy Fair 2021 is an initiative taken by the Indian government from learning by doing to learning by playing for developing interest, better conceptual understanding, increasing experiential learning, developing self-regulation or self-control, mental flexibility and important for developing strong socio-emotional state (Ministry of Education, 2021). The Indian government has also launched an online toy hackathon called 'Toycathon-2021', which is based on development of innovative games or toys based on history, culture, etc.

The NEP 2020 recommends experiential learning, which includes hands-on learning, art

integrated and toy-based pedagogy, sports-integrated education, and story-telling-based pedagogy (National Education Policy 2020, Ministry of Human Resource Development Government of India).

Thus, our study aims and addresses blending of traditional games, toys, and fun activity with science topics to stimulate interest in science subject and foster better conceptual understanding at the Upper Primary Stage. It also comes out that the use of activities, toys and games help in the development of social skills and behavioral aspects.

Research Questions

A. How effective is the teaching-learning process in holistic development of a learner by blending content of science with the traditional games and toys?

B. Can scientific concepts be better understood with the help of games, toys, and fun activities?

Objectives of the Study

A. To study the efficacy of games, toys and fun activities for enhancing the conceptual understanding of science among learners of Upper primary stage.

B. To study the efficacy of games, toys and fun activities for developing learners' interest towards science.

C. To study the efficacy of games, toys and fun activities with reference to learning of Children with Special Needs (CwSN).

Research Methodology

Study Design

The study was framed for *Mohalla* classes where the teachers interacted with limited number of students of their locality, while wearing masks and maintaining social distance due to COVID–19 pandemic. During this period, all schools remained closed for more than eight months. Students in the rural areas were also unable to attend the online classes due to lack of availability of smart phones or computers in their houses. Therefore, the teachers decided to conduct *Mohalla* classes to educate their students. The study was conducted on the students of twenty-one *Mohalla* classes. An intervention module was developed from the handbook for elementary level and only 10 activities (2 fun activities, 6 games and 2 toys) were selected from the handbook for the study and were given to teachers through mail in the form of pdf and along with some videos of how to perform activities, developed by the DESM, NCERT. The steps of this study have been shown in Figure 1.

The independent variable used for the study were games, toys and fun activities given in the handbook for teaching-learning of science at

Fig. 1: Design of the study

Upper Primary Stage. The dependent variables included conceptual understanding and learners' interest in science.

Sample Size and Sampling Method

The orientation programme comprised of 21 teachers (one teacher each from 21 schools) of *Ichhawar* Block, Bhopal, Madhya Pradesh belonging to science background. The sample for the intervention programme comprised of total 116 students of Upper Primary Stage (Classes VI, VII and VIII) from the selected 21 schools. The sample also included two children with special needs (CwSN) from a school located in Delhi due to their non-availability in *Mohalla* classes of *Ichhawar* block. Since the intervention was online, only students with low vision were selected for the same and the number of games, toys and fun activities was restricted to only two for them. The research study comprised of quasi-experimental research design and single group pre-test-post-test method.

Tools for the Study

Questionnaires for teachers, learners and observers were developed by the various science experts from schools and colleges in the workshops held in NCERT. The tools developed for the study are as follows:

A. Pre-orientation questionnaire for teacher
   - To seek information with respect to general and academic information of the respondent science teacher, teaching-learning method adopted, any initiative taken by the teacher to make teaching-learning enjoyable to learners, teacher's interaction with learners in classroom, etc.

B. Post-orientation questionnaire for teacher
   - To seek information with respect to teachers' understanding of games, toys and fun activities to be used during teaching-learning process, assistance to use handbook with CwSN, feasibility of the handbook in developing science concepts, suggestions regarding improvement of the orientation programme, etc.

C. Questionnaire for the feedback on handbook by teacher
   - To seek information with respect to presentation, language, illustrations given in the handbook, the time period stipulated for each activity is enough or not, best features of the handbook, etc.

D. Pre-intervention questionnaire for learners
   - To seek information with respect to learner's interest towards learning science, usually adopted teaching-learning process in science classes, etc.

E. Post-intervention questionnaire for learners

- To seek information with respect to learner's interest towards learning science, activities from handbook adopted in teaching-learning process in science class, etc.

F. Focus Group Discussion (FGD) with learners
   - To seek information with respect to learner's response on various activities, adopted from handbook during intervention stage, to measure the effect on student's interest towards science, etc.

G. Conceptual understanding-cum-achievement tests for selected activities, games and toys from the handbook
   - To seek information on learner's understanding of concepts through games, activities and toys.

H. Observation schedule for intervention phase
   - To seek information on view for the proper implementation of the activity, find out learner's interest towards science, etc.

Orientation Programme

A five days orientation programme for teachers was conducted online to orient them on implementation and strategy to be followed while using the handbook.

Intervention Stage

This study includes two phases, Phase I and Phase II. During Phase I, the handbook on Understanding Science through Activities, Games and Toys at Upper Primary Stage and the efficacy of these activities on conceptual understanding and interest towards science was investigated. This intervention stage was carried out for ten days for conducting ten different activities, to get learners' experiences regarding their classroom learning, their interest towards science and the role of games, toys and fun activities for learning concepts. During the intervention period, the activities were delivered by the teacher to the learners in the form of games, toys and fun activities for better understanding of science concepts and later their feedback was recorded on such teaching-learning method.

Data Collection

Due to technical limitations, the teachers facilitated the process of collecting data from learners using their own mobile phones. Data was collected with the help of eight tools (questionnaires) mentioned in Section 2.3 out of which six were in Google form format for online mode, which are mentioned below:

- Pre-orientation questionnaire for teacher
- Post-orientation questionnaire for teacher
- Questionnaire for the feedback on handbook by teacher
- Pre-intervention questionnaire for learners
- Post-intervention questionnaire for learners
- Conceptual understanding-cum -achievement tests for selected

activities, games, and toys from the handbook (details in Table 1).

Results and Discussions

The efficacy of games, toys and fun activities for enhancing the conceptual understanding of science among learners at Upper Primary Stage was measured at 0.05 level of the significance and of one tailed t-test. Firstly, the mean scores obtained by the learners in the achievement test (pre-test and post-test) of the selected fun activities, games and toys were calculated as given in Table 1. But for getting the significant effect, t-test was calculated (Fig. 2–11) and found that the difference in the mean values were significant at 0.05 level for eight activities out of the ten selected activities. Although there was difference in the mean scores in the achievement test for remaining two activities, but was not found significant at 0.05 level.

This shows the efficacy of games, toys and fun activities mentioned in the handbook in conceptual understanding of the science concept among learners of Upper primary stage.

Table 1

Mean Scores Obtained in the Achievement Test for Selected fun Activities, Games and Toys

Name of the Activity	Type (Game/Fun Activity/ Toy)	Science Concept on which it is based	Mean of Scores Obtained in Achievement test	
			Pre-test	***Post-test***
Intelligent Duck	Toy	Attraction and repulsion between magnets	1.14	1.57
Lifting a cup or a glass tumbler with a balloon	Fun activity	Force and pressure	1.15	1.21
Vibgyor Seven Stones	Game	Splitting of white light	1.13	1.17
Climbing Joker	Toy	Friction	0.81	0.88
Obedient Liquid	Fun activity	Neutralization reaction	0.81	1.39
East or West, Home is the Best	Game	Living organisms and their habitats	0.96	1.16
Dramatise the Motion	Game	Types of motion	1.27	1.41
Dumb Charade	Game	Cell: structure and function	0.69	1.16
Who is my Friend?	Game	Physical and chemical changes	0.87	1.18
Sort me out	Game	Physical and chemical properties of metals and non-metals	1.30	1.50

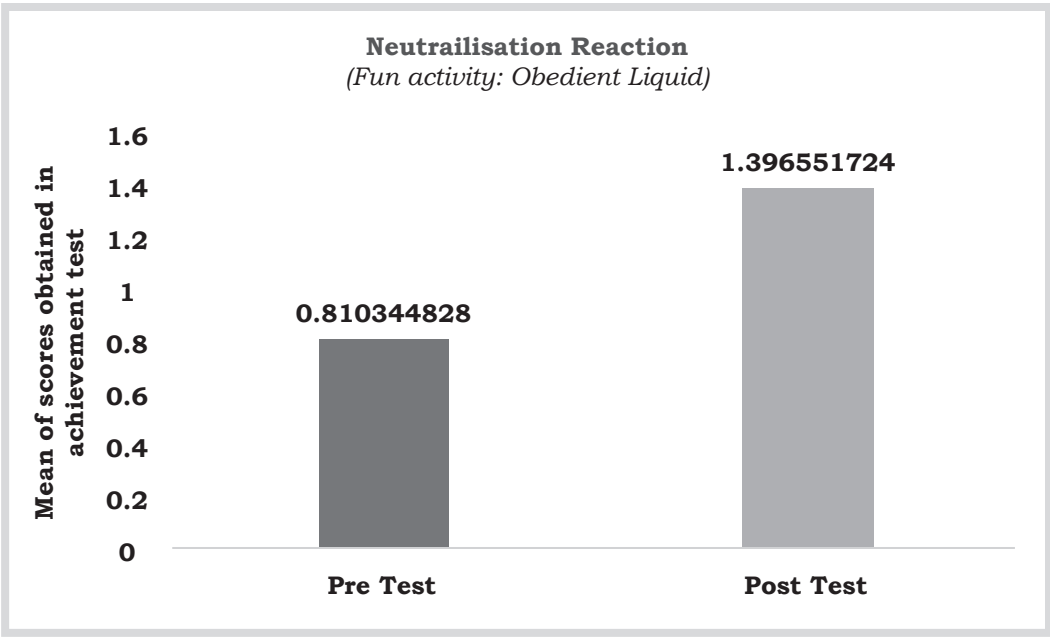

Fig. 2: Difference in the mean value of pre-test and post-test for science concept neutralisation reaction

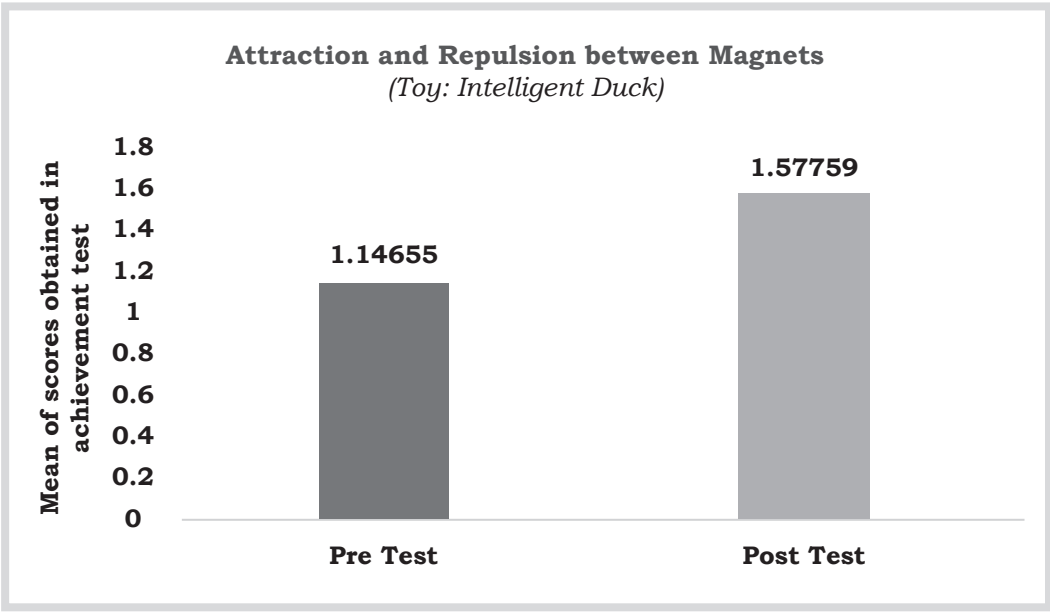

Fig. 3: Difference in the mean value of pre-test and post-test for science concept attraction and repulsion between magnets

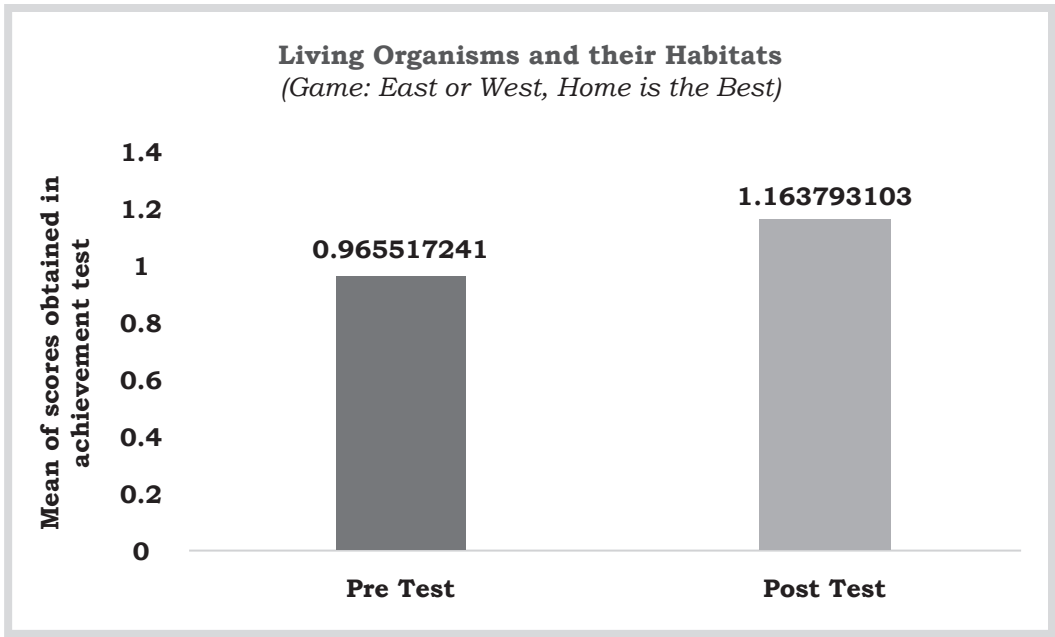

Fig. 4: Difference in the mean value of pre-test and post-test for science concept living organisms and their habitats

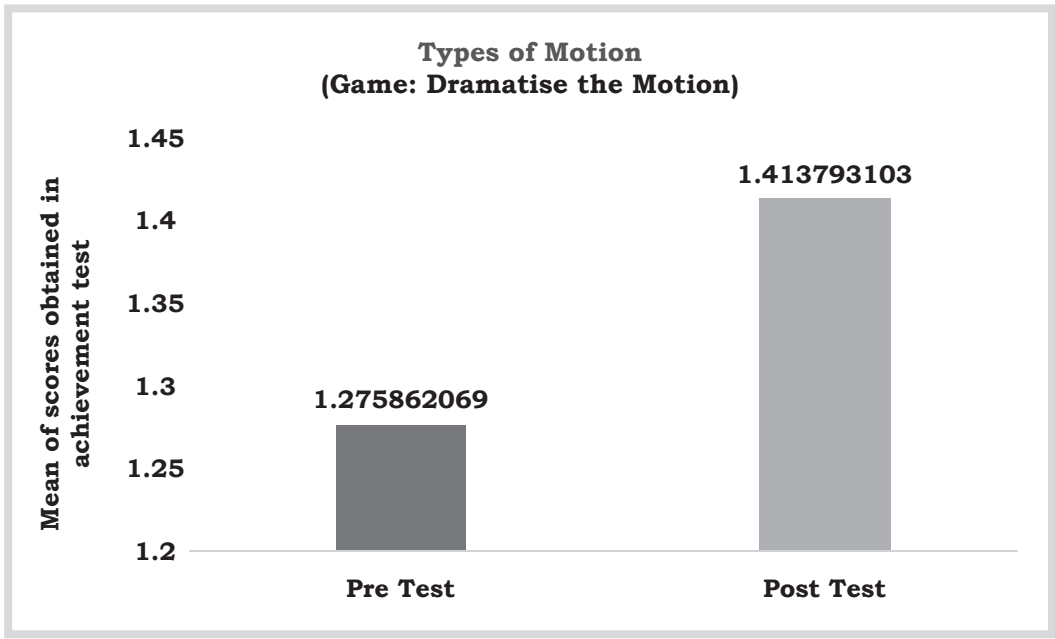

Fig. 5: Difference in the mean value of pre-test and post-test for science concept types of motion

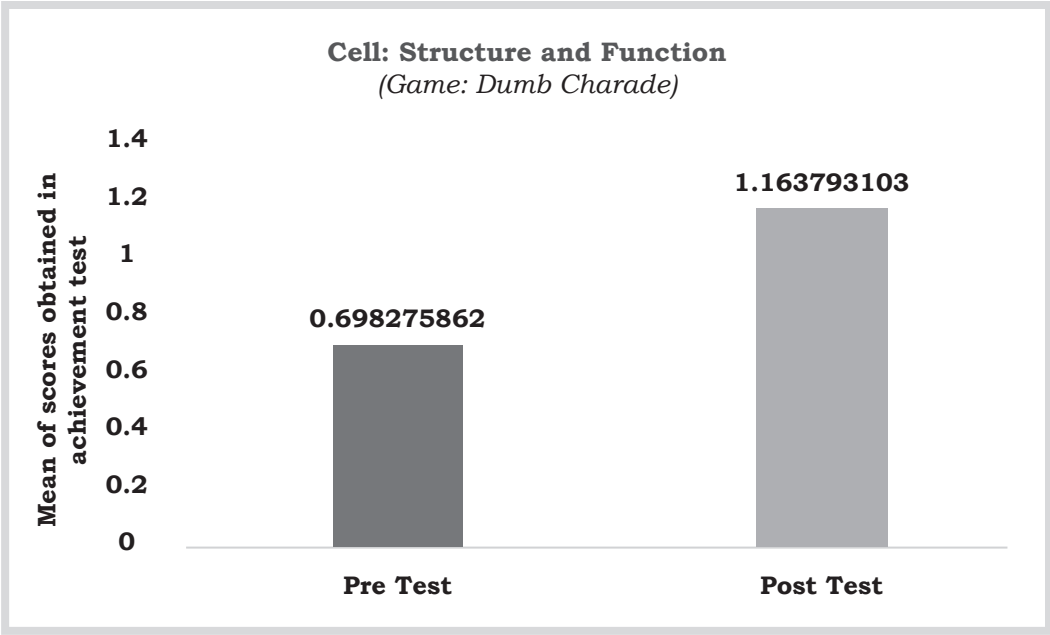

Fig. 6: Difference in the mean value of pre-test and post-test for science concept cell structure and function

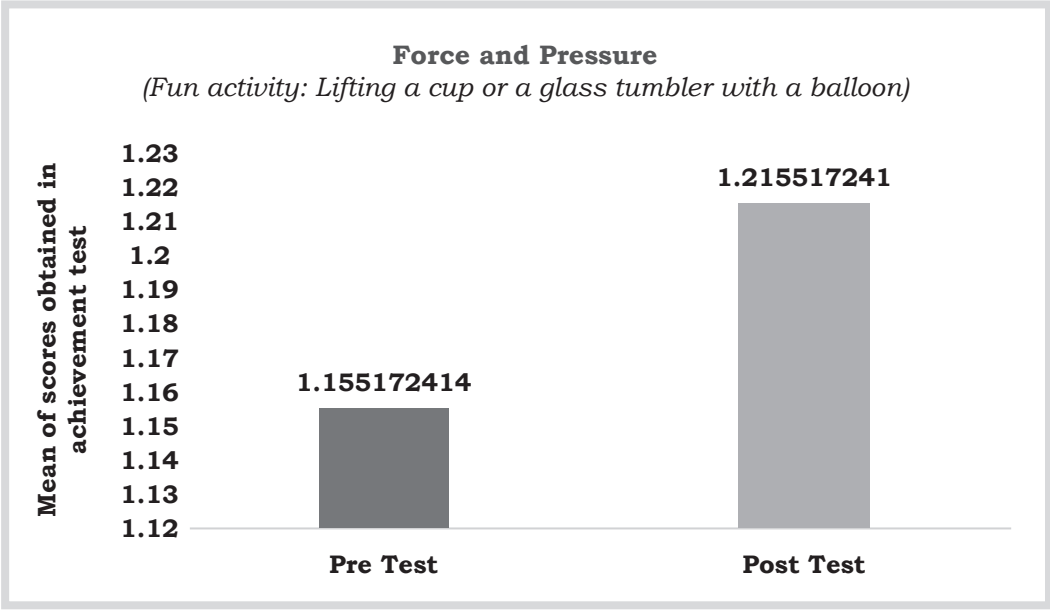

Fig. 7: Difference in the mean value of pre-test and post-test for science concept force and pressure

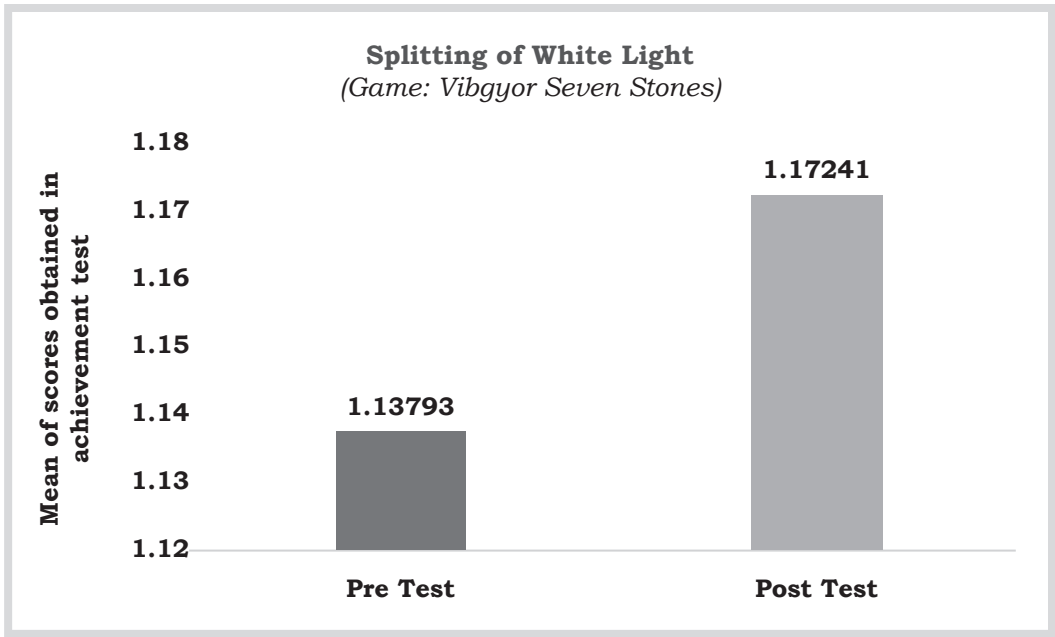

Fig. 8: Difference in the mean value of pre-test and post-test for science concept splitting of white light

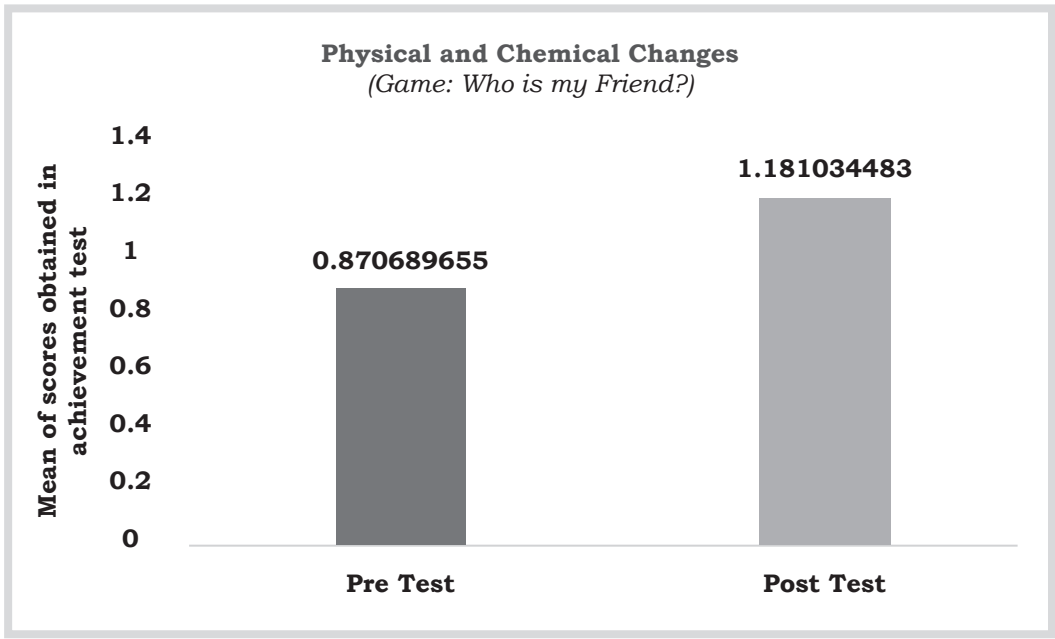

Fig. 9: Difference in the mean value of pre-test and post-test for science concept physical and chemical changes

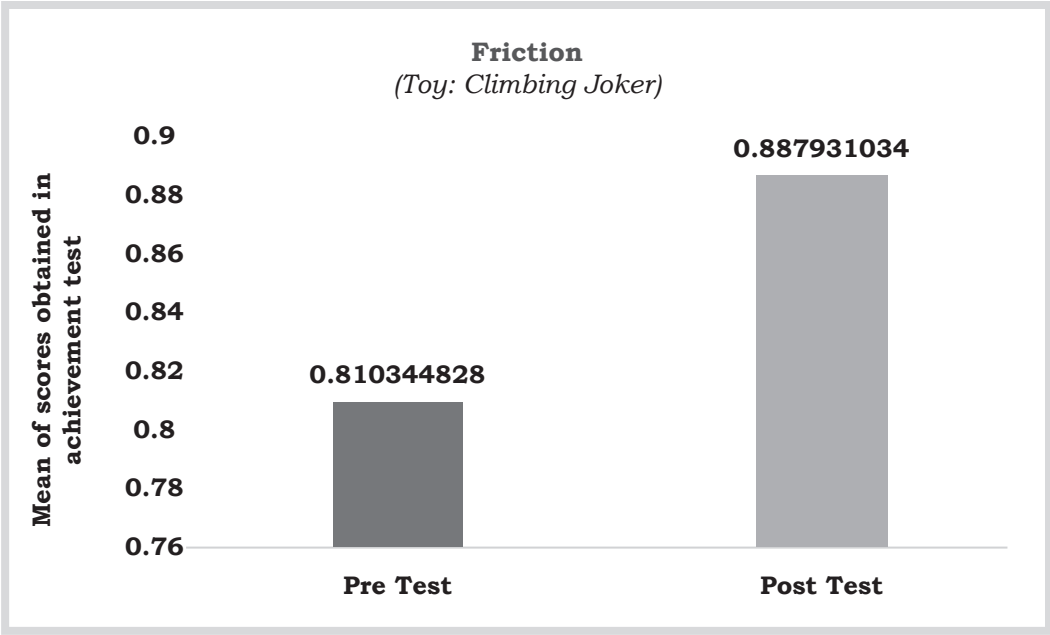

Fig. 10: Difference in the mean value of pre-test and post-test for science concept friction

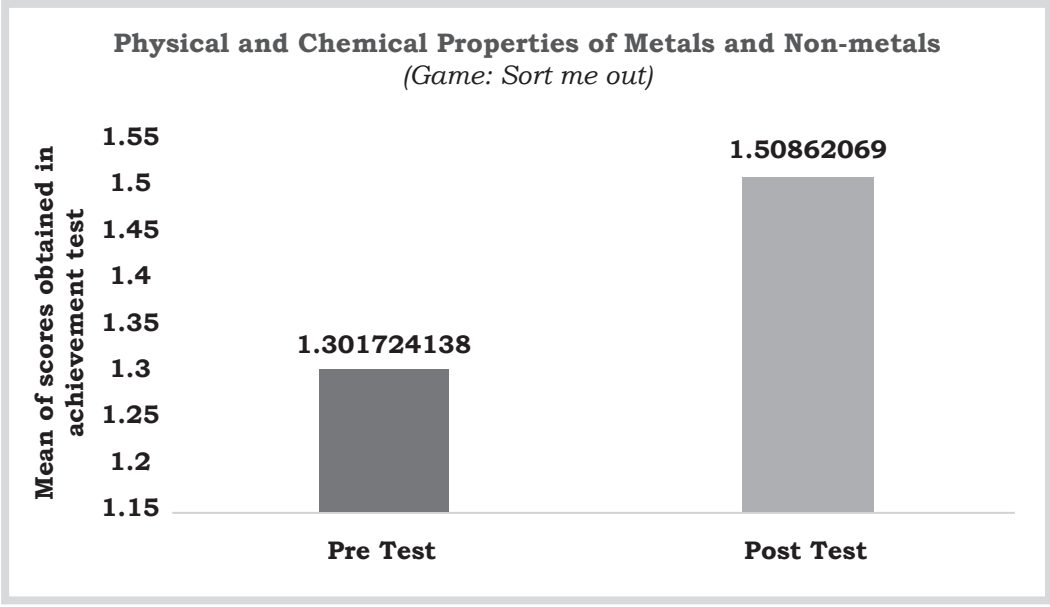

Fig. 11: Difference in the mean value of pre-test and post-test for science concept physical and chemical properties of metals and non-metals

From the filled questionnaires and online interaction with learners technically supported by teachers, it was found that traditional teaching-learning process was shifted towards art integration and their inclination towards science had increased up to 100 per cent. Even a marginal increase in the percentage of learners asking questions to teacher indicated overcoming their hesitation, thus, encouraging child-friendly environment. After intervention, the activities liked and enjoyed by most of the learners were Intelligent Duck, Lifting a glass with balloon, Climbing Joker, Vibgyor Seven Stones, etc. This finding was quite similar to the findings obtained above, where in these similar activities, learners performed very well and developed their conceptual understanding significantly. The enhancement of learners' interest towards science has been shown by the data, which increased from 75.9 per cent (pre-intervention) to 90.5 per cent (post intervention). From the data collected, a significant rise in discussion with peers about the concepts learnt in the class during the intervention period was also observed. Almost all the learners were encouraged by their teachers to interact during the teaching-learning process. The interaction was encouraged both individually and in the groups by the teachers. The learners were ready to perform new activities and liked to learn science through other games also which indicated a rise in their interest towards learning science. The learners found teaching-learning process clubbed with activities, games, and toys joyful and stated that this method helped them to learn better.

In case of CwSN, though there was enhancement in concept development but not significant. It would be rather difficult to conclude the impact of the intervention in case of CwSN in the teaching-learning of science as the number of participants and the number of activities taken were only two (Figure 12 and 13). From their responses it was analysed that earlier they were not discussing with their teachers the issues related to daily life like pollution, dengue, malaria, water contamination etc. but that changed in post intervention.

This innovative pedagogy also made teaching-learning process interesting for them. For learners, it was more interesting, burden free and facilitated long-term retention with clear conceptual understanding and relating the learning with their daily life experiences. We can see that the present study confirmed the findings with a similar study (Shah and Rahat, 2014) which was based on the use of activities in science topics for better conceptual development. This result also supports the findings of another study (Varzani, 2013) where they inculcate the games with the science concept and generate interest towards science. Eltem and Berber, 2021 in his study observed that educational games to teach 'Structure and Properties of Matter' made the teaching-learning process easy, more

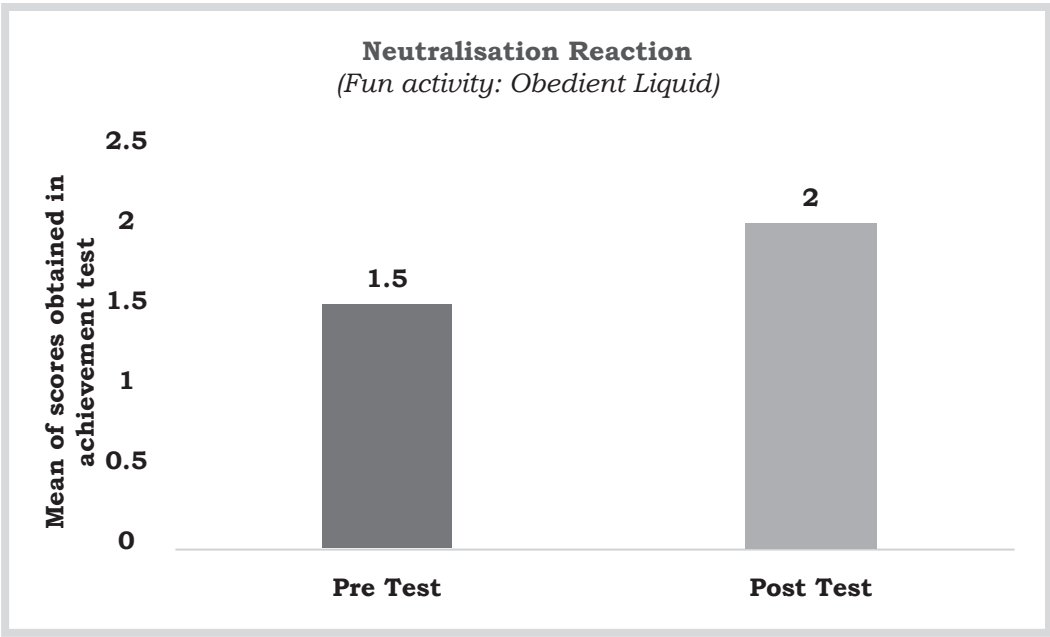

Fig. 12: Difference in the mean value of pre-test and post-test for science concept neutralization reaction (for CwSN)

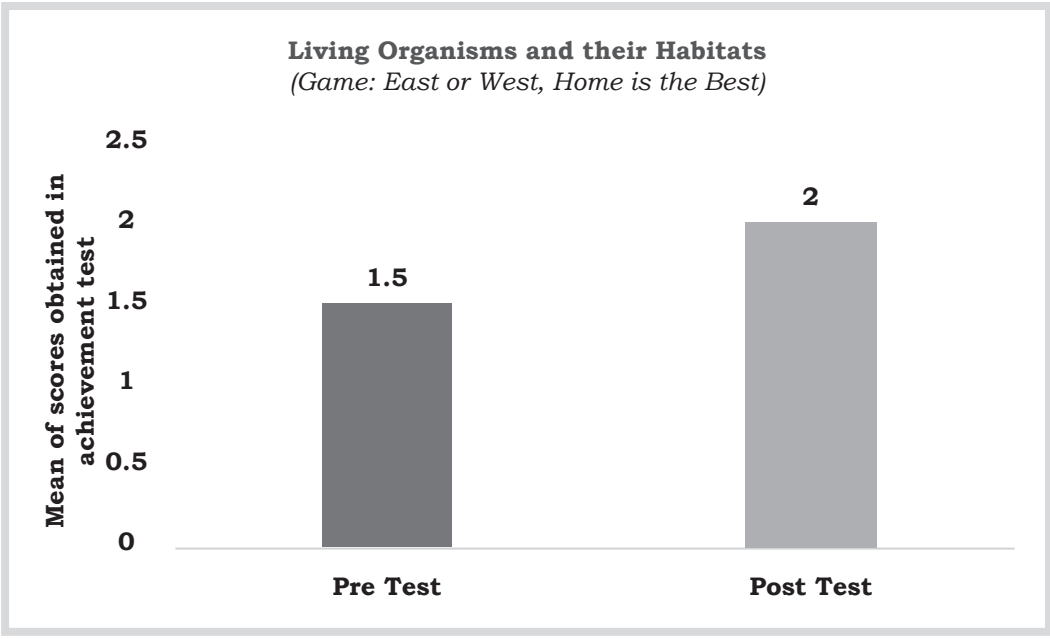

Fig. 13: Difference in the mean value of pre-test and post-test for science concept living organisms and their habitats (for CwSN)

focused, fast and efficient. Students developed permanent learning as well as interest in science through such games.

Conclusion

From the study, it can be concluded that games, toys and fun activities show positive impact on learners' conceptual development and enhances their interest towards learning science. The result of the study shows that despite limited access, eight activities had given the significant effect on conceptual development in science. Another promising finding was that the activities given in the handbook showed efficacy on developing interest of learners towards science and marginal efficacy in case of CwSN. The teachers also acknowledged that their thinking had changed towards the use of the game, toys and fun activities in science topics. Our results also found evidence that the blend of games, toys and fun activities with learning is the need of the hour. Thus, our study reduces learners' reading burden and makes education more enjoyable through games, toys and fun activities. The knowledge taught through such method leaves an indelible mark on the human mind and brain. This study will also serve as an eye-opener for teachers who believe that scientific principles can only be explained through laboratories, costly equipment and activity rooms. During the pandemic, despite many limitations, this study has been a successful effort.

However, this research cannot be generalised as it was done in *Mohalla* classes (made according to the situation) rather than in the normal classroom. Nevertheless, it will act as a guideline for other future studies which will use games, toys and fun activities for conceptual development and enhancing interest towards science.

Scope for Further Study

I. The results of the present study can be replicated by taking a larger sample size in a mainstream school to make it more reliable and generalisable.

II. The study can be done on all other activities included in the handbook.

III. This study can also be undertaken for comparing the efficacy of handbook on different zones or regions.

IV. This study can be undertaken for comparing the efficacy of the handbook on different parameters like gender, class-wise and between different categories of schools (i.e., Government, aided and private school).

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