

Strengthening conceptual understanding of science by use of science kit at middle stage of schooling

Anil Kumar Nainawat, Ved Prakash Arya*, Om Prakash Meena

vedprakash@rieajmer.ac.in

Department of Education in Science and Mathematics, Regional Institute of Education, NCERT, Ajmer
(India)- 560012

Abstract

Learning best happens by experience and it is especially true for science. Direct meaningful experiences are crucial in science. Laboratory work is very important for conceptual understanding of scientific concepts, but laboratory resources are not readily available to most of the learners in the rural schools of India. Science kits thus become useful learning resource for such schools. NCERT, New Delhi developed science kits at every stages of school education. One such kit is Upper Primary Science Kit (UPSK). It is designed to contain many items and materials which encompass almost all the concepts mentioned at middle (now secondary) stage of school education. The evaluation of science kits becomes important to determine their effectiveness in improving students' science knowledge, and creating positive attitude toward science. This study is an attempt to explore the impact of science kits on conceptual understanding of Science, attitude toward Science, at middle stage students' in ten selected schools of Hurda block of Bhilwara district of Rajasthan state in India. The results indicate that science kit and their use in the classroom have improved students' conceptual understanding of science.

1. Introduction

Science is exploration of the natural world following a systematic methodology based on evidence. According to Albert Einstein, "The most beautiful experience we can have is the mysterious. It is the fundamental emotion which stands at the cradle of true art and true science". Young learners are always keen to discover and explore something new through play and innovative ways. Science and discovering things are like two faces of a coin in terms of involvement one shows and goes deep into matter. In everyday life, involvement of science is all- pervading; all our activities are surrounded by science. Science is just

an extension of things we see and observe in daily life, it just relates to how these things are possible. It is particularly stressed by the National Education Policy 2020 to encourage experiential learning (Kolb, D. A., 1984 and National Education Policy, 2020, para 4.2, 4.5-4.7, and 5.15). Promoting science to spark interest and foster a lasting passion for its exploration is a global priority. In India, numerous efforts have been made to tackle this challenge. Modern science education now focuses on cultivating a 'scientific attitude' and broader 'scientific literacy.' The aim is to engage with science through hands-on experimentation and a deeper understanding, rather than just memorizing factual content.

Proper experimentation is part of laboratory work in science, which is not practiced in most of the schools. In such a case, science kit becomes a source of performing experiments also. Many researches are conducted on the importance of science kits in the learning of science by several groups across the world. In a study on “Implementing Inquiry Kit Curriculum: Obstacles, Adaptations, and Practical Knowledge Development in Two Middle School Science Teachers”, two elementary certified middle school science teachers are studied for practical knowledge transformation that intended to support the implementation of kit-based enquiry (Jones M.T. & Eick C.J., 2007). The study focused on how these two pilot teachers conducted inquiries directed to their specific academic and curricular interests as well as how to adapt children to the use of science and technology. Their findings suggest that teachers, as professionals, require collective and individual support in the classroom for becoming enquiry-oriented teachers. In a study entitled “Science Kit Teaching Aid for the Earthquake in Improving Students’ Collaboration Skills and Creative Thinking in Junior High School”, the results showed that the use of IPA Kit teaching aids for earthquakes was more effective in improving students' creative thinking skills and collaboration (Atun S., Latupeirisa V.P.S., 2021). In another study “Science Kits as Resource: Some Pedagogical Considerations”, twelve sampled science kits were evaluated for their 'educational utility', and their role in generating enthusiasm and interest in science through hands-on activities (Jaimini N., 2014). A study on “Differential use of Elementary Science Kits” examined elementary teachers' instructional strategies, classroom practices, and assessment types in relation to the frequency of science kit use. Teachers using kits reported that their students designed and implemented laboratory investigations as well recorded, represented, and analyzed data (Jones G., Robertson L., Gardner G.E., et al 2011). In a chapter on "The nature and role of science kits in affecting change in public attitude toward understanding of science" two example cases of kit implementation are discussed (Dickerson D. L., et al. 2014). An interesting study was conducted on “Constructing Scientific Knowledge in the Classroom” (Driver R, Asoko H., Leach J., Millar, et al 1994).

According to this study, knowledge cannot be transmitted but must be constructed by the mental activity of learners underpins contemporary perspectives on science education. This article presents a theoretical perspective on teaching and learning science in the social setting of classrooms, and is informed by a view of scientific knowledge as socially constructed. They illustrated how both personal and social perspectives on learning, as well as perspectives on the nature of the scientific knowledge to be learned, are necessary in interpreting science learning in formal settings. A study on “Using Science Kits to Construct Content Understandings in Elementary Schools” examines the efficacy of science kits in improving content knowledge. The method used involved treatment and comparison groups composed of 2,299 elementary school students in third, fourth, and fifth grades from ten different schools. In all the pairings but one, there were statistical differences in favor of the treatment groups or no statistical differences, suggesting that science kits enhance students’ content understanding (Dickerson D., Clark M., et al 2006). Another attempt was a study on “The Use of Science Kits in the Professional Development of Rural Elementary School Teachers”. This study reports on a science professional development initiative with elementary school teachers in Canada. Grades 4 and 5 teachers were involved in the implementation and modification of science kits, together with corresponding professional development activities. Each kit was aligned to specific outcomes in the curriculum and provided a complete set of materials and guidelines for classroom use. Teachers describe, through surveys and interviews, the benefits of using the kits and share a new confidence for teaching science (Sherman A. and MacDonald A.L., 2008). An evaluation study was conducted to assess elementary school science kits in terms of classroom environment and student attitudes. The purpose of the study was to compare students' perceptions of their science classroom environment when using science kits, textbooks, or a combination of science kits, textbooks, and teacher-created materials. The findings revealed that positive classroom environments contribute to improved student achievement. (Houston L.S., et al, 2008). Another study, titled "Understanding the Impact of a Kit-Based Science Resource on Teachers’ Ability to Engage Students in Science: An Interpretative Phenomenological Analysis," explored the effects of using science kits. The findings suggest that teachers' confidence and enthusiasm for teaching science were enhanced through the use of the kits. Additionally, students were reported to have gained a deeper understanding of scientific concepts. (Larsen K., 2014). The paper entitled “Effects of Science Kit/Inservice and Kit Use on Teachers' Science Knowledge, Attitudes, and Teaching” shows how science kit/in-services have affected elementary teachers' science knowledge, attitudes toward science, and science teaching practices in several schools in Southwest Michigan. Findings indicate that the use of science kit in the classroom have increased teachers' science knowledge, positive attitude toward

science, and science teaching skills (Rubino A.N., Barley Z.A., Jenness M., 1994). Another study indicated a significant improvement in students' scientific skills, cognitive learning outcomes, and interest in natural science through the use of science kits (Satria E., 2015).

In India, NCERT plays a key role in overseeing school education and has developed science kits for all educational stages. These kits are being procured and utilized by numerous schools across the country. It is crucial to assess their impact on the teaching and learning process. The present study focuses on the Upper Primary Science Kit (UPSK) to examine its effect on enhancing students' conceptual understanding of science. The study was conducted in 10 schools located in rural areas.

2. The purpose of the research

Fostering an interest in science and cultivating a lasting passion for its exploration is a global priority. In India, numerous initiatives have been launched to tackle this challenge. The definition and purpose of 'Science Education' are being reimagined to focus on developing a 'Scientific Temper' and enhancing 'Science Literacy.' This shift has significant implications for teachers, as they play a crucial role in facilitating the teaching and learning process in the classroom.

The role of 'science kits' as a resource material in generating excitement and interest in science through hands-on activities has long been recognized. There has been a strong emphasis on learning science by doing. However, the actual scenario has not been very promising, as science kits have often not found their intended place in science classrooms. Recently, however, both school and teacher education curricula have increased expectations, urging teachers to ensure that their students become active participants in constructing knowledge. As a result, teachers must be equipped with the skills to evaluate and adapt existing science kits, whether developed by NCERT or modified versions, to meet their specific needs. This study aims to enhance students' understanding of science concepts using science kits, compared to traditional teaching methods, in the schools of Hurda block, Bhilwara district, Rajasthan.

3. Methodology

Objectives of the study:

1. To improve conceptual understanding and skills to use the science kit effectively.
2. To find out the effect of science kit on scientific inquiry to carry out hands on activities.

Research Questions:

1. Does conceptual understanding of science at elementary level improve with use of science kit?
2. Do the scientific inquiry skills of students of elementary level improve with use of science kit?

Research Design:

The presented research is based on quasi-experimental method. The design was single group Pre-Test Post-Test control group design.

Sample of the study:

The present study was undertaken for the 10 schools of the Hurda block of the Bhilwara district of the Rajasthan state in India. These schools were identified from the list provided by the education authorities of the district. These schools were upper primary, secondary and senior secondary schools. All schools were personally visited by the principal investigators and selection of schools was done on the basis of keen interest of students as well as the teachers of the schools.

Finalization of tools:

To collect the desired information, the research tools were developed with the help of in house faculty members of the different subjects related to science. The tools developed in house were finalized in the vetting and finalization 2-days workshop. In this orientation cum tool finalization workshop, the Science teachers of the selected schools participated in one-day interaction and external resource persons of different subject of the Science and institute faculty members participated as resource persons. The Finalized tools were utilized for collection of data.

4.Results and Discussion

To know the Impact of Science Kit on Conceptual Understanding of Science at Middle Stage, 10 Schools of Hurda Block of Bhilwara District of Rajasthan state were selected. These schools were supplied NCERT Upper Primary Science Kit (UPSK). A Pre-Test was administered for all the students of class 8th for checking conceptual understanding of the students. After supply of UPSK to the schools, Science teachers were asked to use the kit for their real classroom transaction. To know the actual use of kits in learning-teaching processes, observation schedules for teachers were also organized. After using science kit, a Post-Test was organized for the same students. The results of these tests are presented below.

About Pre-Test

Pre-test contained 20 questions from science concepts of upper primary stage. Concepts covered are as follows:

Identification of fabric, properties of metals, sodium metal, acids and bases, evaporation of water, types of motion, shadow formation, pinhole camera, conductors, bar magnet, properties of magnet, effect of electric current, identifying different parts of a plant, types of plants, water from different sources, biodegradable and non-biodegradable waste and its management.

Students' responses in Pre-test

Fig. 1 is the representation of data in the terms of % marks obtained by students in Pre-test. Marks vary from 24.3 % for Govt. Upper Primary School, Pardodas to 66.4 % for Govt. Girls Upper Primary School, Hurda. Overall correct response in Pre-Test is 39.52%. In general, Upper Primary schools have low performance in comparison to Secondary and Senior Secondary schools.

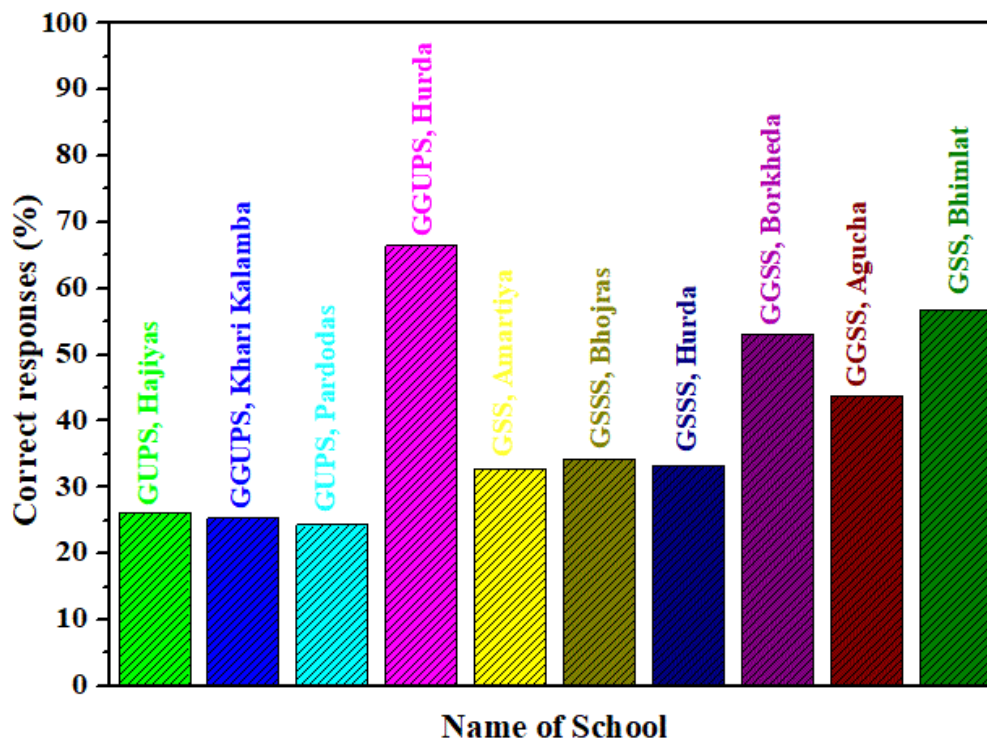


Fig.1. School wise % marks in Pre Test

About Post-Test

Post-test also contained 20 questions from science concepts of upper primary stage. Concepts covered are as follows:

Properties of metals, reaction of metals, sodium and Potassium metals, chemical reaction of Magnesium, hydrogen gas, oxygen gas, combustion, biodegradable and non-biodegradable waste, identification of lenses, stethoscope, production and transmission of sound, sunlight, image by plane mirror, angle of incidence and angle of reflection, multiple reflections, microorganisms.

Students' responses in Post-test

School wise data is shown below in the terms of % marks obtained by students in Post-test. Marks vary from 23.9 % for Govt. Secondary School Amartiya to 81.1 % for Govt. Upper Primary School, Pardodas. Overall correct response in Post test is 51.07 %, which is 11.55% more than the Pre-Test (i.e. 39.52%). It is interesting to note that the best performer school in the post test is the one which was at the bottom in pre test. Graphical representation of the data is given in Fig. 2.

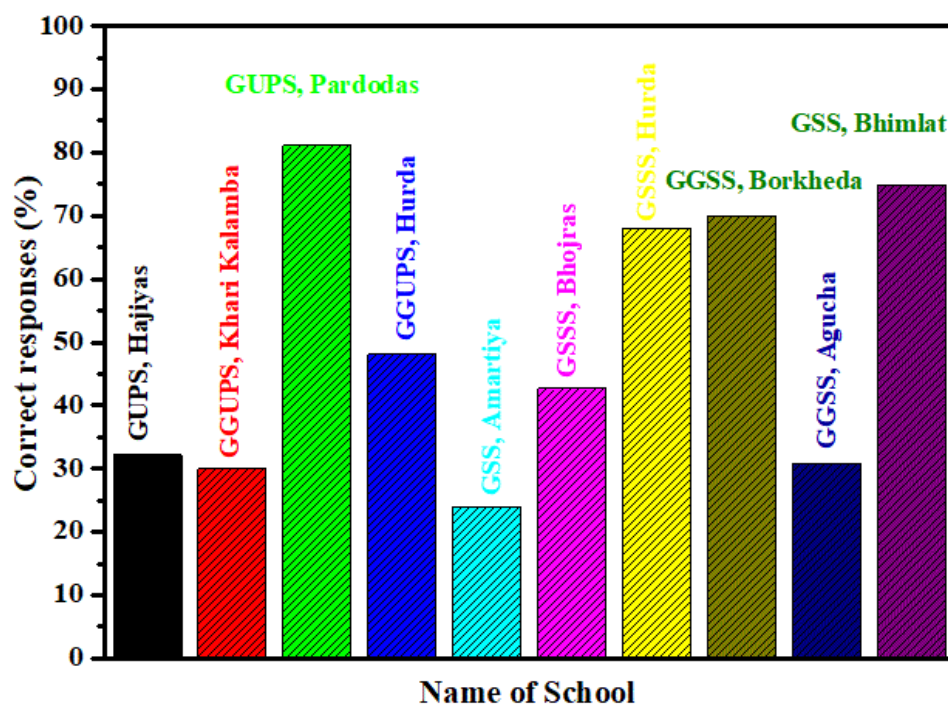


Fig.2. School wise % marks in Post Test

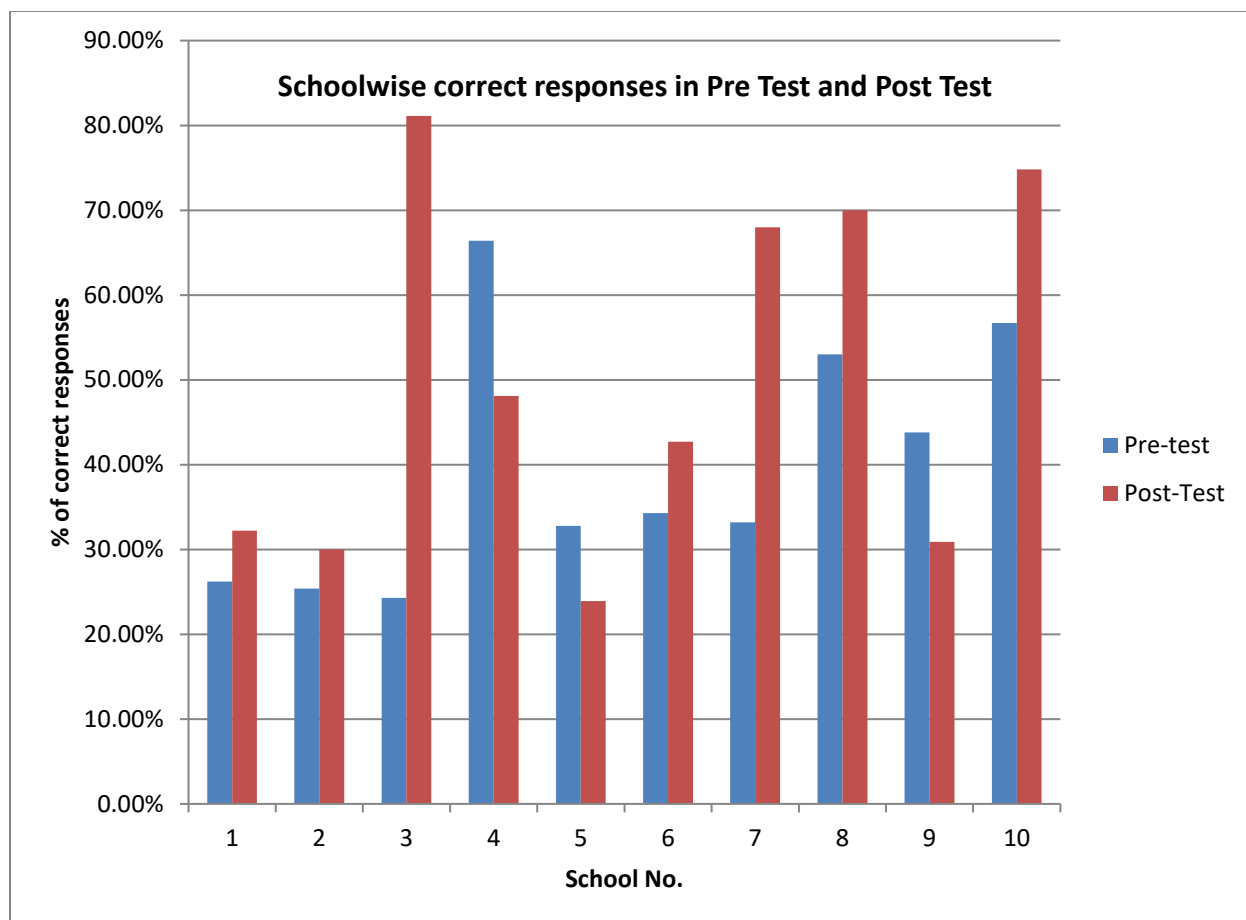
Table 1 shows the results of Pre-Test and Post-Test in different selected schools. It is clear from the data that there is improvement of performance for 7 schools out of 10 schools in the Post Test which can be

contributed to the use of science kit in teaching-learning processes. The improvement is significant in some of the cases. For example, school 3 has jumped from 24.28 % to 81.13 %. It is important to mention that this school has lowest performance in Pre Test. School 7 has also a good improvement from 33.16 % to 68.07 %. Three schools i.e. schools No. 4, 5, and 9 are the exceptions with slight decrement in the score in Post Test. Overall, there is a positive impact of science kit with improvement of score from 39.52 % in Pre Test to 51.07 % in Post Test i.e. increment of 11.55 %.

Table 1. School wise responses in Pre-Test and Post-Test

School No.	% Correct response in Pre-Test	% Correct response in Post-Test
1	26.17	32.22
2	25.45	30
3	24.28	81.13
4	66.36	48.12
5	32.77	23.86
6	34.31	42.69
7	33.16	68.07
8	53.05	70
9	43.78	30.86
10	56.73	74.77
Overall	39.52	51.07

Graphical representation of comparative performance of selected schools in Pre-Test and Post-Test is given in Fig. 3.



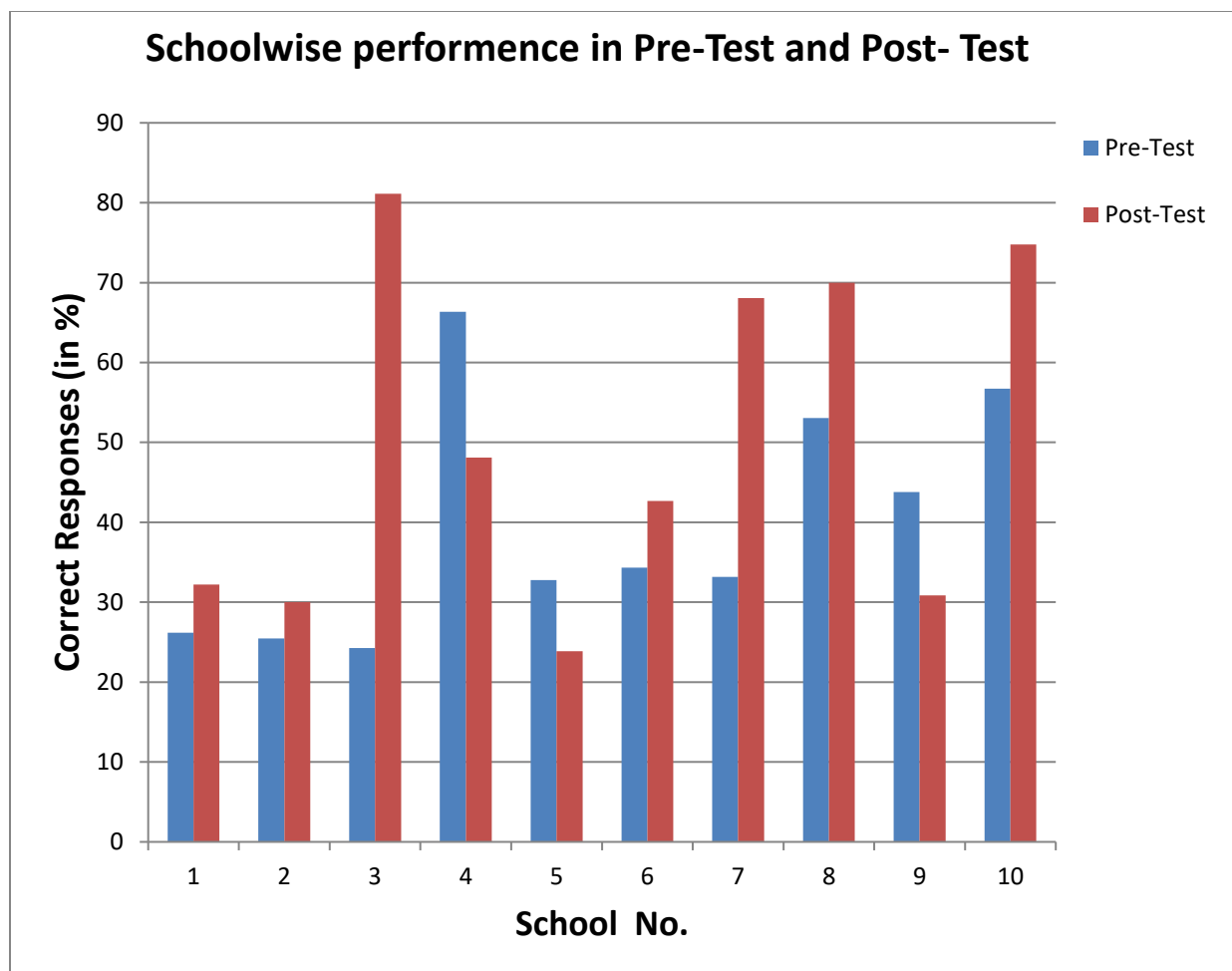


Fig. 3. School wise responses in the Pre-Test and Post-Test

5.Conclusions

Science is an experimental subject which has scope of verification. It gives confidence to believe in the scientific principles and results. Thus experimentation is an integral part of science, which convinces the learner. Formal experimentation is done in the laboratories, which are space consuming and costly to establish. Science kits are good alternate to the laboratories as these are very handy and cost-effective. Direct observation and learning by doing are definitely superior to the lecture method. It is, therefore, natural to assume that the use of science kit will have a positive impact on the learning of science. With this assumption, the present research study was undertaken and the results obtained from 10 selected

schools of Hurda block of Bhilwara district confirm the assumption. Impact of the use of science kit was perceived in the terms of performance in Pre Test and Post Test. Statistical analysis shows that 7 schools out of 10 schools recorded the better performance in the Post test compared to Pre test. Overall score of the schools in Pre Test was 39.52%, which increased to 51.07% in the Post Test. Straight increase of 11.55% is thus achieved. Some schools have shown remarkable improvement. For instance, Govt. Secondary School Amartiya topped in the Post test, which was at the bottom in Pre Test.

It is not only the statistics which matters, but also the experiences of the students and teachers regarding the use of science kit. Students told that they were able to understand science in much better way by using science kit. They could see many things happen for the first time and they could believe that the concepts given in books are true and science is true. Learning became interesting for them. They understood the concepts by doing experiments. They came to know that how important science is for their life. Use of science kit helped in better and stable learning of the concepts.

Finally, the implications of this research study are as follows:

- Conventional mode of teaching and mental burden on students for the sake of their school examinations was the hurdle for achieving the goals of science kit. Their involvement could be more.
- Time assigned for the science class was not sufficient for the extensive discussion on the topics of science dealt by the science kit.
- Alternative frameworks do play an important role in the learning. They are so deep rooted that even after treating the group by the use of science kit, alternative frameworks persist. For right concepts to develop, continuous and systematic efforts are required.
- Use of the science kit enhanced the collaboration among learners.
- Students were given less autonomy to use the science kit. Otherwise results could have been much better. Students should not be feared in using the science kit.
- Most important thing noticed by the use of science kit was that it became a fun to learn science for the students and their whole perception of learning science was changed. They became interested in the learning.
- In spite of all these constraints, the present study indicates that the science kit has a positive impact on conceptual understanding of science and it should be available to all the schools for making the learning of science joyful and engaged.

Use of Science kit is definitely a way forward for the better conceptualization in the science at middle stage.

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