Science kits as resource: Issues and challenges

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Abstract

The use of science kits is a growing trend in India. The kits provide equipments, apparatus and chemicals in the form of a moving laboratory to use in science classes.

This research paper highlights the issues and challenges faced by the Government school teachers of Delhi in India while using science kits during teaching-learning process at upper primary and secondary stages. In this study 40 Government schools of Delhi, India were approached. The result reveals that most of the teachers are using science kits during teaching-learning process but suggestions for improvement of these kits have been received for proper utilization of these kits particularly for inclusive classrooms.

Keywords: National Curriculum Framework-2005, Science kits, Activity-based teaching

Introduction and Review of literature

It has been observed that the use of traditional methods of teaching science results in the rote learning and lack of understanding of concepts. If, proper resources are not available, then teachers are bound to choose traditional way of teaching. The important feature of activity based teaching is that it is learner centric. It also allows the learner to study according to his / her own abilities and skills. Studies have shown that activity based teaching is more effective for the development of higher order skills among students (Khan,M.,et al., 2012). It has also been observed that students with disabilities benefit from learning science through activity-oriented approach (Mastropieri, M. A., & Scruggs, T. E. 1994).Thornton, 2001 remarks in teaching physics concepts with activity-based learning greatly improves students learning and understanding of scientific concepts. Choo, 2007 noted the positive impact of activity based learning approach on the students as well as on teachers in a vocational institution. Hung etal., 2008 mentioned that activity based learning has positive impact on students' abilities to apply basic science knowledge and transfer problem-solving skills in real-world professional or personal situations. Suydam et al, 1977 and Shepherd, 1998 reported same kind of results. Coulson and Osborne, 1984 and Blumberg and Michael, 1992 reached on the similar conclusion about the impact of activity based learning.

Science educators encourage to replace traditional teacher-centered instructional practices, such as emphasis on textbooks, lectures, scientific facts, with inquiry-

oriented approaches that (a) engage students interest in science, (b) provide opportunities for students to use appropriate laboratory techniques to collect evidences, (c) require students to solve problems using logic and evidence, (d) encourage students to conduct further study to develop more elaborate explanations, and (e) emphasize the importance of writing scientific explanations on the basis of evidence (Secker,2002).

Stofflett, 1998 pointed out that the traditional classroom often looks like one-person show with a largely uninvolved learner. Traditional classes are usually dominated by direct and unilateral instruction. Traditional approach followers assume that there is a fixed body of knowledge that the student must come to know. Students are expected to blindly accept the information they are given without questioning the instructor. Even in the activities based subjects, although activities are done in a group but do not encourage discussion or exploration of the concepts involved. This tends to overlook the critical thinking and unifying concepts essential to true science literacy and appreciation (Yore, 2001).If learners are provided the opportunity to think and solve the problems on their own then the learning becomes long lasting.

In India, the National Council of Educational Research and Training (NCERT) is a leading body for school education. It is an autonomous body constituted by the Government of India. The main functions of this organization are: curriculum development; research; teacher training; extension activities; evaluation and consultancy. National Curriculum Framework-2005(NCF-2005) recommends the pedagogy of science with the focus on hands-on experiences and inquiry based processes. Focus Group Position Paper on Teaching of Science (NCERT, 2005) discusses about process validity that leads to generation and validation of scientific knowledge, nurture the natural curiosity and creativity of a child. It also recommends a pedagogy that is hands–on and inquiry-based.

The textbooks in science at upper primary (NCERT, 2005, 2006 & 2008) and secondary stages (NCERT, 2006 & 2007)have been developed in the light of NCF-2005.The entire approach of the books is, in fact activity based, i.e., students are required to construct knowledge by themselves with the help of these activities. In addition to that laboratory manuals in science at upper primary stage (NCERT, 2014) and secondary stage (NCERT, 2009, 2010) have also been developed. These manuals are complementary to textbooks and aims at enhancing learners' comprehension of scientific concepts and also acquiring basic experimental skills. In the learning of science, emphasis is on enquiry approach and hands-on experience instead of lecture method alone. Inspite of these efforts, it has been observed that the general practice has tended to be dominated by chalk and talk methods. One of the major structural problems that plague science education at these levels is the lack of experimental facility. It is a known fact that most of our rural schools have no laboratory facilities,

and the children are put to great disadvantages because they are deprived of the excitement of performing activities. In order to fulfill this need, science kits have been designed and developed by the Division of Educational Kit, NCERT at upper primary and secondary stages. The Kits have the following advantages:

- availability of necessary pieces of apparatus/ items at one place
- multipurpose use of each piece of apparatus
- economy of time in setting up of activities/experiments
- portability from one place to another
- provision for innovation
- low cost and use of indigenous resources.
- environment friendly

The science kits developed at upper primary and secondary stages are based on science textbooks developed by NCERT. The kits have been distributed in schools in different parts of the country for making desirable changes in the teaching-learning process. These kits provide scope for various learner centered activities on the concepts of science given at upper primary and secondary stages. Since the textbooks are in use for almost a decade and kits are being provided in the school system, a research study has been taken up by the Department of Education in Science and Mathematics (DESM), NCERT with an objective to find out the extent to which activity based teaching-learning is being followed by using science kits [Figure 1] and orientation of teachers in using these kits.

Figure1: Science kit

Research questions

- Are the kits available in schools?

- To what extent these kits are being utilized?
- Is there any difficulty faced by users while using the kits and modification(s), if any, suggested for the kit items?

Research design

Research Tool

A common tool for upper primary and secondary stages in English and Hindi was developed. The tool was reviewed and finalized (Appendix).

The tool has two parts:

Part I - General information about availability of science kits in schools.
Part II - Feedback from the respondent teachers about use of science kits.

Collection of Data

The Directorate of Education, Delhi was approached to allocate 40 Government schools of Delhi on the basis of availability of science kits. Nearly 120 teachers were involved in this study. The list of the schools was provided by the directorate, where both the kits for upper primary and secondary stages were available.

The tool was administered in 40 Government Schools. There respondent teachers were given freedom to fill the tool either in English or Hindi as per their convenience. There was also verbal communication with teachers regarding use of these kits, the difficulties, if any, they are facing while using these kits during teaching-learning process.

The data was collected and analyzed.

Analysis of data

Research Question-1: Are the kits available in schools?

At least one science kit each at upper primary and secondary stage is available in each school. The science kits are available in schools from last 6 months to 4 years. Majority of the teachers are satisfied with the number of kits available in the schools. At upper primary stage, 61.80% teachers are satisfied with one kit because some schools have laboratories also.38.20% teachers desired to have more number of kits

because of the large number of students. Since one kit is too less to give hands-on experience to students and ultimately these teachers land up by demonstrating the activities. Similarly at secondary stage, 75.71%teachers are comfortable with the number of science kits available, while 24.29% teachers suggested having at least 4 to 6 science kits in each school.

Provision for replenishment and maintenance of these kit items is usually done from the funds allocated under Rashtriya Madhyamik Shiksha Abhiyan (RMSA) or from school funds given to science department or science clubs etc.

This information has been revealed from question numbers10, 11, 12, and 15.

Research Question-2: To what extent these kits are being utilized?

Some of the teachers could utilize the science kit items appropriately at both the stages; however, some were facing difficulty because of lack of training. In most of schools, it was found that training was provided to one or two teachers only of each school, due to which teachers were finding difficulty in using most of the kit items (from question 6). Data shows at upper primary stage 39.33% teachers have attended training programs and more than half i.e 60.67% teachers never got opportunity to attend any training programme on usage of science kit.

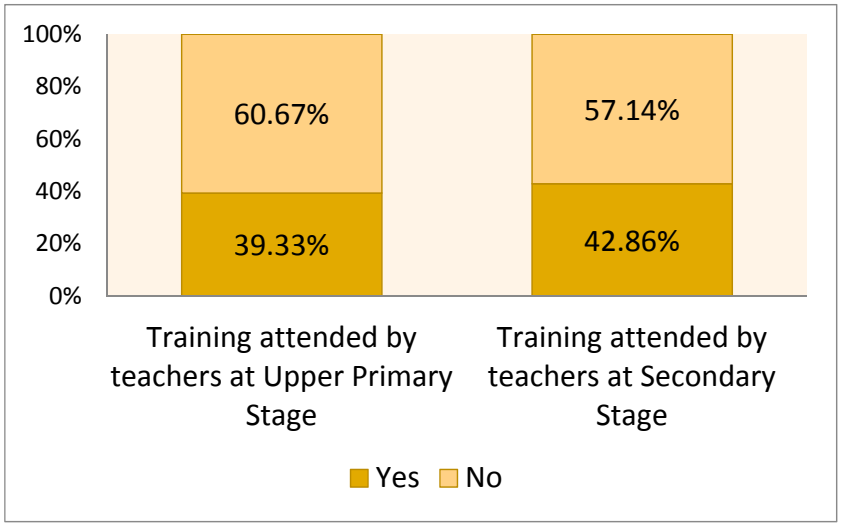

Figure 2: Training attended by teachers at upper primary and secondary stages

Similarly at secondary stage also 42.86% teachers have been trained through the programmes conducted under Sarva Shiksha Abhiyan (SSA) or Rashtriya Madhyamik Shiksha Abhiyan (RMSA) or by State Council of Educational Research and Training (SCERT) or District Institute of Education and Training (DIET) for 4-5 days. More than half i.e 57.14% teachers never got any opportunity to attend any

training programme [Figure 2]. Analysis of data (from questions 7 and 8) also confirms that less than 50% teachers were trained in using these kits. They were trained one time when kits were arrived at school. Usually one teacher is trained from each school as master trainer and it is expected that this master trainer will train rest of the teachers of that school. It is also expected that if new teacher joins the school, she should be trained by the master trainer. Since these teachers couldn't get any support either from any master trainer or from any mentor and that is why they face difficulty in using science kits.

The data shows nearly 60% of teachers use science kits for demonstration during teaching –learning process [Figure 3]. Some of them also provide opportunities to students for hands- on activities for the topics related to light, magnets, chemical reactions, pH etc.

Figure3: Demonstrating activity using kit items

At upper primary stage 70% teachers are unable to give hand-on experience to students because of high strength of students in class. The maximum numbers of students reported in one section are between 70 to110. At secondary stage, due to the availability of laboratory [Figure 4], science kit is used only when experiment is being demonstrated by the teacher as and when required.

Figure 4: Glimpses of science laboratory in school at secondary stage

In figure 5, Data shows that at upper primary stage 58.43% teachers mostly use science kit, 37.10% teachers sometimes and 4.58% of them rarely. At secondary stage 54.29% teachers use mostly, 38.60% sometimes and 7.14% rarely because of availability of laboratories .In laboratory each student get opportunity to work independently. From this data one can analyze that the teachers want to utilize the science kit during teaching-learning process.

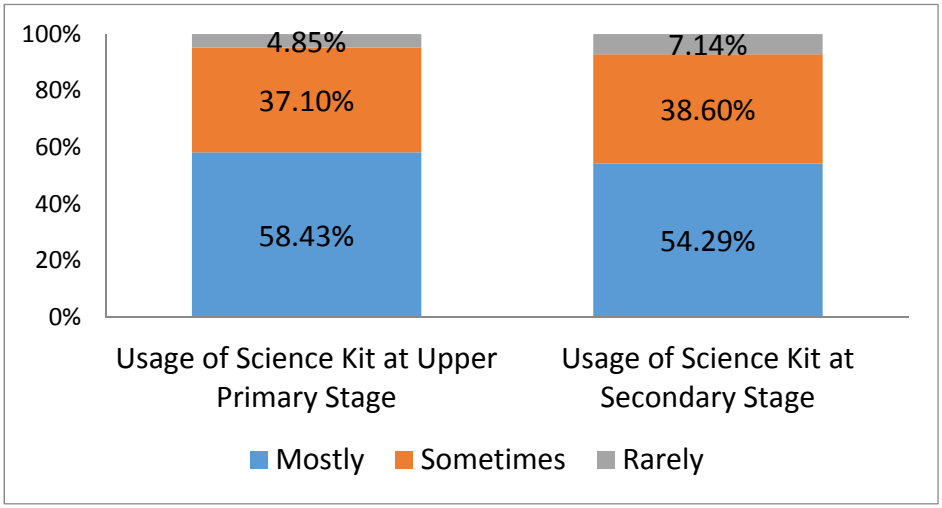

Figure 5: Usage of science kits

The data shows (from question 17) that teachers face difficulty in recognizing and naming the kit items. Some teachers are not even aware about the use of these kit items (the pictures of kit items of upper primary stage and secondary stages are given in the Tool).This indicates that teachers need proper training on how to use kit items which are provided in the science kits. The kit items which teachers find convenient to use are-bell jar, beakers, test tubes, lenses, mirrors, clamp stand, Newton's disc etc. (from question 18).The kit items which teachers find difficult to use are - rheostat, dissecting microscope, electroscope assembly, generator, W-tube, multimeter (from question number 9 and 19). These items are provided in the kits of both upper primary and secondary stages. Teachers reported that all the activities are feasible at

upper primary stage but at secondary stage it is difficult to perform ohm's law activity (from question number 23), because students find difficulty in making circuit.

In most of the schools teachers claimed that kits are being used during teaching-learning process, however, the visits in schools and on analyzing data, it shows that kits were not being utilized to the extent these should be.

Research Question-3: Is there any difficulty faced by users while using the kits and modification(s), if any, suggested for the kit items?

Due to the large number of students in each class, teachers face difficulty in demonstrating the activities and also providing hands-on to each student. In each section minimum number of students is 40 and maximum number is 125.Since more than 50% teachers are not trained in using these kits; they face difficulty in handling deflagrating spoon, generator, electroscope, magnesium ribbon, etc. It was also shared by all that they find difficult in placing items back in the kit, may be due to size of the kit and lack of availability of space. Nearly 20% teachers suggested that the heating device, microscope and slinky does not work properly after being used two/three times and also instead of stove, spirit lamp may be provided.

Spring balance less than 250 least count, solar panel related material should be added to the kit items and also more quantity of the chemicals should be provided. 10% teachers also suggested that diode, mirrors, lenses, prism and Newton's disc may be provided more in number so that each student can be given hands-on. They also desired that the manuals should be provided in the science kit box and not separately.

Nearly 60% teachers suggested that glass items may be replaced by plastic items particularly for visually impaired students. Where ever possible teachers mostly demonstrate activities to these children. Teachers have demanded for improvisation of kit items so that hands-on experience can be given to these students (from question number 5, 6, 10, 12, 17, 19, 21, 23, 24, 25, 26). For example, glass items to be replaced by plastic items, improvised apparatus and audio material to be provided for visually impaired students etc.

Conclusion

The main purpose of this research study was to know whether science kits are available and utilized by teachers during teaching-learning process. The study also helped in identifying the difficulties faced by teachers during transacting the concepts in the class with the help of kit items. It was found that generally teachers are using science kits during teaching-learning process. At least one teacher from

each school is trained for using these kits. They use these kits for demonstration of activities/ experiments due to the large number of students in each class. It is difficult for them to give each student hands-on experience. On the basis of analysis, it can be concluded that teachers are also using laboratories along with the kit items at secondary stage. Suggestions have been given for the modification of microscope, slinky, quantity of chemicals to be increased, number of some of the items to be increased, such as diode, prism, mirrors, lenses, Newton's disc and modification in the kit items for visually impaired students. The need of a manual with the kit itself is highly demanded.

Recommendations

The schools were visited and tool was administered. After analyzing the data and observing the classroom processes, following recommendations are suggested:

- SSA, RMSA, NCERT, SCERT, DIET etc., may take up more programmes to train large number of science teacher, teaching in the Government School of the country for using these kits.
- In Government schools teacher's job is transferable. Therefore, if one teacher of the school gets trained, it should be mandatory for the trained teacher to train other teachers of the school and also of nearby schools.
- The teacher pupil ratios in Government schools need to be relooked to encourage activity based teaching.
- As and when NCERT will modify kit items and kit boxes, kit manual should be packed along with the kit items.
- To make Kit items more users friendly, video recording of usage of kit items should be done and can be the part of kits. The recorded videos can also be uploaded on NCERT website.
- Designing of kit needs to be relooked by focusing on portability and placement of items in a kit.
- A group of mentors may be recognized region wise to give hand holding to the users as and when required.
- Strict quality monitoring of kit items and chemicals need attention.

This research study motivates to take up another study to see how effective these kits are in students' academic achievement in learning science.

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Appendix

Tool

The information provided in this tool will be used only for research purpose

The Tool has two parts:

Part I - seeks general information about availability of science kits in schools.
Part II –seeks information/feedback from the respondent teachers about use of science kits.

Note: The Tool should be filled by Respondent Teacher teaching science at the upper primary stage (classes VI, VII, VIII) and /or the secondary stage (classes IX, X).

Part – I

1. Name and full address of the school with pin code :

1.1. Telephone No. of school with STD code :
1.2. e-mail ID of school :

2. Designation of the teacher responding to the tool :

3. Qualifications of the teacher: Higher Secondary with science

Yes	No

(a) Educational Qualification

Graduation :
(mention the subjects)

Post-graduation :
(mention the subjects)

(b) Professional Qualification

(B.Ed. /DLEd./Any other)

4. Total experience of teaching :

Science (in number of years)

For Upper primary	
For Secondary	

5. Science subject being taught in the current academic year by the teacher.

Stages		Classes taught by the teacher Please tick(√)	Number of sections being taught by the teacher	Total no. of students in (Average)
Upper primary	1	2	3	4
	VI			
	VII			
	VIII			
Secondary	IX			
	X			

6. Training/orientation programmes on use of science kits.

S. No.	Title of training/ orientation programme	Level upper primary or secondary	Training/Orientation programme organized by SSA/RMSA/DIET/ SCERT/NCERT Any other (specify)	Year in which programme was organized and duration of programme	Training strategy (ies): demonstration/ lecture/hands on/ Any other (specify)	Remarks
1	2	3	4	5	6	7

7. Availability of mentor/support as and when required for using science kit.

8. After getting trained, were involved in training to other teachers?

9. Do you need more training in the context of handling the science kit ? Please tick (√)

Stages	Yes	No
Upper primary		
Secondary		

(a) If yes, please mention below the aspects, topics etc., on which you need more training in handling the science kit

10. Availability of science kits.

Stages	Number of science kits available	Are the numbers of kits sufficient? please tick(√)	If no, how many additional science kits are required	Remarks if any
Upper primary		1 Yes ☐ No ☐	2	3
Secondary		Yes ☐ No ☐		

11. Is there provision for replenishment and maintenance of kit items?
Please mention below in the space provided

12. Do you have easy access to kit items in your school?

	Yes	No
Upper Primary		
Secondary		

If **NO**, give reason(s).

13. Science textbooks used:

(i) Upper primary - NCERT/ others (Please specify)

(ii) Secondary - NCERT/others (Please specify)

Part II

Information/ Feedback from the respondent science teacher about use of NCERT science kits.

14. (a) Do you use science kit during teaching- learning process? Please tick (√)

	Yes	No
Upper Primary		
Secondary		

(b) If yes, please mention the purpose of use of science kit. Please tick (√)

(i)For demonstrating experiments/activities

	Yes	No
Upper Primary		
Secondary		

If yes, Please list 5 activities.

(ii) For providing opportunities to students for hands-on activities.

	Yes	No
Upper Primary		
Secondary		

If yes, Please list 5 activities.

15. Number of years, the science kits has been used during teaching-learning process?

Stages	Number of years of use of science kits	Remarks, if any
Upper primary	1	2

Secondary		

16. How often do you use science kits during teaching-learning process?

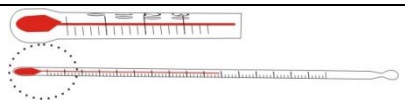
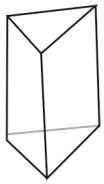
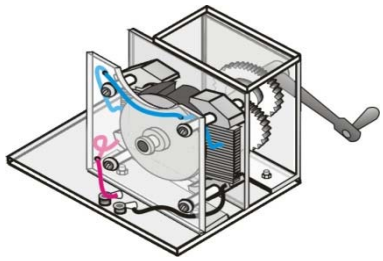
Please tick (√)

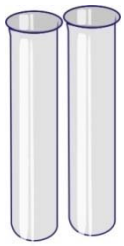
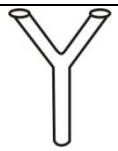
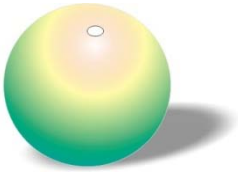
Stages	Use of science kit			
	Mostly	Sometimes	Rarely	Remarks
Upper primary	1	2	3	4

Secondary				

17. Given below are pictures of some kit items. Write name and use against the picture of each item.

Kit Items

Sl. No.	Picture	Name of the Item	Use(s)
1.			
2.			
3.			
4.			

5.			
6.			
7.			
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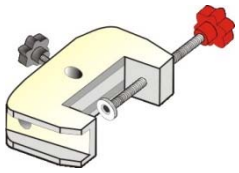
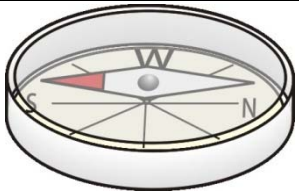
10.			
11.			

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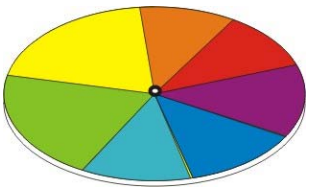
14.			
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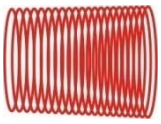
16.			
17.			
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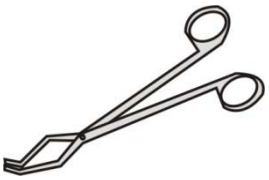
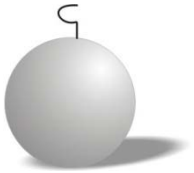
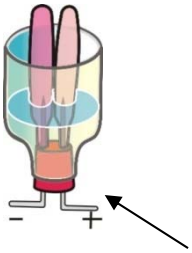
19.			
20.			
21.			
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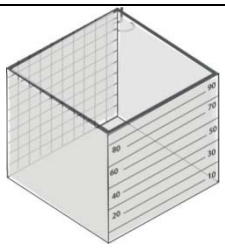
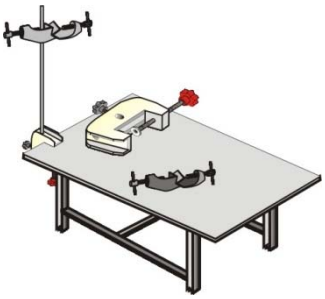
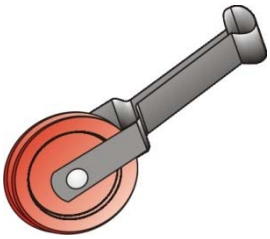
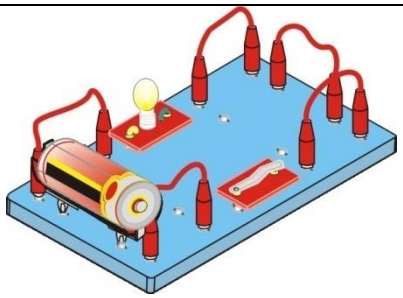
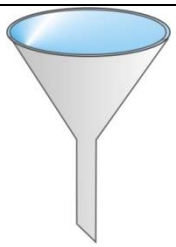
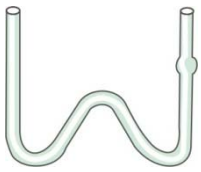
26.			
27.			
28.			
29.			
30.			

31.			
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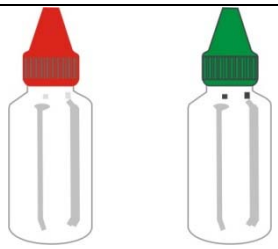
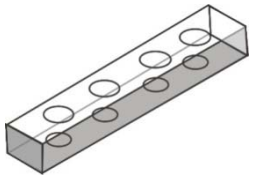
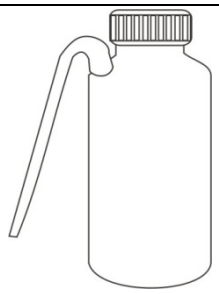
34.			
35.			
36.			

18. Which item of the science kit do you find convenient to use?

Stages	Items of science kit found convenient to use	Remarks

Upper Primary	1	2
Secondary		

19. Which items of the science kit do you find difficult to handle and why?

Stage	Items of science kit found difficult to handle	Reasons/Remarks
Upper Primary	1	2
Secondary		

20. What difficulties do you face while using the science kit? Please mention.

21. Activities which you demonstrate by using science kit during teaching- learning process.

Class wise		Activities demonstrated by using science kit	Remarks if any
	1	2	3
Upper Primary	VI		
	VII		
	VIII		
Secondary	IX		
	X		

22. Do you use science kit for assessment and evaluation of students? Please tick (√)

Yes	
No	

(a) If yes, please mention the skills/abilities assessed.

(b) If not, please state the reason(s).

23. Activities not feasible using the science kit

Stage		Which activities you find not feasible using the science kit?	Reasons/Remarks
Upper Primary	1	2	3
	VI		
	VII		
	VIII		
Secondary	IX		
	X		

24. Science kit items that need modification?

Stages	Name science kit items that need modification	Reasons for modifications and nature of modification needed	Suggestions for modifications
Upper Primary	1	2	3
Secondary			

25. Usefulness of science kit for students with special need (Differently abled children (Children with special needs are: blind, low vision, hearing impaired children, children with orthopedic handicaps, intellectually impaired).

Stages	Is the science kit useful for students with special needs? please tick(√)	What difficulties do you face while using the science kit in teaching-learning of children with	Which science items need modification for teaching-learning of students with

			special needs?	special needs?
	Yes	No		
Upper Primary	1	2	3	4
Secondary				

26. Write your suggestions for improvement of kit.

Date _____

Place_____