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Pedagogical Process in Science at Government Secondary Schools of Odisha

Abstract

Considering the broader aim of Science education as cultivating scientific literacy among citizens of the country by developing a sense of inquiry, rational thinking, and objectivity through varied exploratory activities, examining the process of science learning in schools is very significant. The intention of this paper is to present the findings related to pedagogical processes in Science with respect to content, pedagogical strategy employed, resource management and assessment. In this exploratory research, qualitative survey method has been adopted and 51 schools from 6 districts of Odisha participated. The pedagogical process is captured using classroom observation, FGD with students and interview with Science teachers. A checklist was used to examine the laboratory facilities in the schools. It was found that activity based classes were very limited. A teacher centred process with question and answer session was observed predominantly in the classrooms. Hands on activity as a pedagogic medium was not much explored in the classrooms. However, in a few schools, efforts are made to motivate students by involving them in science exhibition and science quizzes. It was also found that laboratory and ICT tools were not integrated to the teaching-learning processes. More involvement of teachers and their commitment to the profession may lead to better planning of the lesson. The findings indicate that there should be conscious effort from all the stakeholders to revamp science learning processes in Government Secondary schools of Odisha.

Introduction

Science is a human enterprise and it distinguishes from other ways of knowing through the use of empirical standards and logical arguments. In Science, experimentation and theory building complement each other. The process of science depends both on making careful observations of phenomena and on inventing theories for making sense out of those observations. In addition, the processes and ideas of science are of great importance to everybody in varied ways and it helps in taking well-informed decision. Therefore, understanding science and its processes are of great significance. In a progressive forward-looking society, science can play a truly liberating role, helping people escape from the vicious cycle of poverty, ignorance and superstition (NCF, 2005). The opportunities provided at school to understand nature in a more scientific way is one of the most important pre-requisites for the same.

Curriculum and Pedagogical Process in Science at the Secondary Stage

Science, as a compulsory subject in the school curriculum reiterates its epistemological function, in addition to the pragmatically based disposition to contribute to technologically advanced society. At the secondary stage, Science is considered as an interdisciplinary composite subject.

Considering the nature of Science, NCF 2005 reiterates the need for involving students in hands on activities. It offers systematic experimentation as a tool to discover/verify theories with scope for learning science through locally relevant resources. Since all phenomena are not directly observable, inference and interpretation are also to be integrated in the curricular process. At this level of schooling, the role of technology in helping learners to visualise and comprehend various natural phenomena cannot be ignored. All these curricular processes are to be followed to make students understand the product aspects of science as well as acquire the skills that lead to generalisation and validation of scientific knowledge. This would help learners to understand science as a social enterprise and can relate scientific knowledge to their immediate and global environment. Imbibing curiosity, creativity and aesthetic sense are not to be ignored in the realm of validation of scientific knowledge. Effective ways of creating scientific temper among learners should to be the major thrust area of any science curriculum at the secondary level. Socio-scientific issues could be addressed through teaching-learning process in Science at this stage.

The appropriate pedagogical processes is very significant in the process of uplifting our children into a more rationalised community who can ask questions, reflect on various socio-cultural issues, involve in productive argumentation and so on. Different documents such as NCF-2005 suggest science education which is true to child, true to life and true to science and envisages a learning environment wherein child constructs knowledge out of experience. The document has also emphasised this attribute of Science curriculum by specifying the requirement for adopting different validities of Science curriculum such as cognitive, content, process, historical, environmental and ethical validity. It also specifies an approach of teaching-learning process based on critical pedagogy. A constructivist based classroom which is open for children to question, involve in productive dialogue and discussion, building knowledge based on subjective reality of children wherein the teacher is a reflective practitioner would lead to a healthy, stimulating classroom environment. The contemporary view of learning is that individuals actively construct the knowledge they possess (Mestre and Cocking, 2000). In this regard the role of the Science teacher in acquisition of scientific knowledge in a Secondary Science class cannot be underestimated (Arubayi, 2015). This is very essential to a paradigmatic shift from subject centred, teacher centred dogmatic classroom situation. In this regard, analysing the pedagogic processes in a Science classroom becomes inevitable to address the quality issues in learning and suggest initiatives to revert the pedagogy into a powerful medium for quality change in the government school scenario of India. Genome (2012) defined the place of the teacher in Science as "making the science come alive by illustrating how classroom Science applies to the professional laboratory and make the students aware of the relevance of science to their lives". Opportunities are to be provided for children to hypothesise, make connection, experiment, critically observe and understand the pattern underlying natural phenomena. The pedagogical processes are to be in this direction with scope for reflecting on the interface between science, technology and society. A greater responsibility is on the part of teachers to provide meaningful learning experiences in Science using various pedagogical strategies with the help of appropriate learning resources such as a laboratory, science kit etc.

Context of the Study

As discussed earlier, Science, being a domain of inquiry, demands a learning process which helps children to explore the world with rigour. In this context, various initiatives are undertaken by Government of India (GOI) through its flagship programmes such as Rashtriya Madhyamik Shiksha Abhiyan (RMSA) in collaboration with State

Governments to improve quality learning in Science. Unfortunately, the pedagogical process of Science was not being given due regard compatible with the facets of nature of Science. A case study conducted by OMSA (2016) in Odisha revealed that TLMs, Labs, Libraries are not used regularly by students and teachers in schools. There are few researches conducted on Science classrooms to understand the subjective reality of pedagogical processes (Karamustafaoglu, Bayar and Kaya, 2014; RMSA, 2016). However, in the context of Odisha, in-depth studies were not conducted to study the pedagogical processes in Science with reference to content, pedagogical strategies, resource management and assessment. The studies conducted to analyse the processes in science at schools of Odisha is very few. In this scenario, State Coordination Committee of Odisha suggested to undertake an in-depth research to understand processes in Science at secondary schools of Odisha. Accordingly, it was approved by PAC of NCERT to conduct a research on this very significant element of Science education. Hence, this research is intends to give a real picture of Science learning in the state so that it helps authorities to plan for better Science learning at secondary schools. The challenges in ensuring the validities of science curriculum at government schools have to be understood not in isolation, but by considering the subjective reality of the context. In this context, a qualitative survey was conducted with an intention to examine the pedagogical processes in government secondary schools through classroom observation, interview with science teachers and focus group discussion with students.

Objective

The objective of the study is to examine pedagogical processes in Science existing at Secondary schools of Odisha with respect to

a) Content
b) Pedagogical strategies adopted
c) Resource management
d) Assessment

Research Design

The present research followed an exploratory research. It was an attempt to study the situation qualitatively to unfold naturally whatever emerges.

Sampling and Sample

Stratified random sampling method was employed for selection of the sample. Out of 30 districts of Odisha, 6 districts were selected, 2 each from 3 revenue divisions. From the Southern division, Ganjam and Koraput districts have been selected, from the central division, Khordha and Balasore and from the Northern division, Keonjhar and Sambalpur were included in the study. Data was collected from 51 schools covering these 6 districts. Nine government secondary schools from each district except Sambalpur with 6 schools were included. 51 secondary school Science teachers from these districts had participated in the study. One Focus Group Discussion with ten 9th standard students was conducted in each school. The study was delimited to 9th standard students and Science teachers who teach these students.

Tools and Techniques

Classroom Observation Schedule: This tool was used by the investigator to observe the pedagogical processes in the 9th standard Science classroom at Government Secondary Schools of Odisha. The observation schedule was of three parts. Part I is regarding the background information about the teacher and the observed class, Part II is for observation of classroom practices and Part III for the observer's points of reflection and remarks.

Interview with Science Teachers: This tool was used for seeking information from the Science teachers regarding pedagogical processes followed in Science in class IX of their schools. The interview schedule was developed to get more information about the other aspects of Science pedagogic processes

which was less possible for the researcher to capture during classroom observation.

Focus Group Discussion: This tool was used for examining the views of 9thstandard students about the teaching-learning process in Science in their school.

Check List: This tool was used for seeking information regarding the availability and functionality of science laboratory equipment, chemicals, charts, working and demonstration models and specimens which are essential for conducting experiments/ demonstrations for 9th standard students.

Analysis of pedagogical processes in Science existing at Secondary schools of Odisha with respect to 'content'

Content is one of the most important aspects of the pedagogical process in Science as like other subjects. The relevance of the provisions of concepts in the curriculum depends largely on the perception of the teacher who is expected to transact those in the classroom. To explore relevance of the concepts in Science, data was collected by using Classroom Observation Schedules, interview with Science teachers and Focus Group Discussion with the students.

51 classrooms in 51 schools from 6 districts were observed with the help of an observation schedule. Out of 51 teachers, it was observed that 36 (70.58%) teachers teaching Science graduated in biology and 15 (29.41%) teachers graduated in Physical Science. It was also observed that most of the teachers from biology background opted to teach life science concepts when the classroom observation was done. These teachers that content from Physical Science was difficult for them to transact in the classroom. The frequency and percentages of each category of the observed data are mentioned below in the table.

Table 1.1: Analysis of the pedagogical process w.r.t content (N=51)

Items	Yes f (%)	Partially f (%)	No f (%)
Linking content with Prior knowledge	27 (52.9)	12 (23.5)	12 (23.5)
Proper Sequencing of the content	42 (82.4)	6 (11.8)	3 (5.9)
Items	**Often f (%)**	**Sometimes f (%)**	**Never f (%)**
Correlating with real life situation	20 (39.2)	22 (43.1)	9 (17.6)
Examples and Activities beyond the textbook	5 (9.8)	23 (45.1)	23 (45.1)
Raising Higher Order Thinking questions in the class	2 (3.9)	15 (29.4)	34 (66.7)

From the above table, it is clear that in 53% of the classes teachers linked the content with prior knowledge. In 23.5% of the classes, prior knowledge was either partially or not linked to a new content in a class. It is observed that 82% of the classes have properly sequenced the content in the class. However, only 39% of the classes often correlated the content with real life situations-while the remaining 61% of the classes have either sometimes or never correlated the content with real life situations. While 10% of the classes provided examples and activities beyond the text book only 4% of the classes raised Higher Order Thinking (HOT) questions in the class.

From the analysis of teacher's interview schedule it was found that 22 (43.13%) teachers opined that the content of the class IX Science book is appropriate to the level of the learners. But 11 (21%) of the teachers

said that the content was difficult for the learners. These teachers were mostly from remote places in the district- Koraput and Ganjam. For example one of the teachers in Ganjam stated that *"The content is not difficult for a normal class IX students' level, but it is difficult for our students where most of the students are slow learners. Even some students cannot write properly."* It indicates that the teachers perceive difficulty in the content with respect to the learners' prior knowledge and performance. In addition to this, a few teachers consider the Life Science part easier than the Physical Science part.

25.49% the teachers also mentioned that the content is not sequential with respect to the organisation of chapters in the Science textbook. They expressed that in the Life Science unit 'Cell and its Organisation' should come first, then 'Tissue' followed by the chapter 'Biodiversity'. Many teachers expressed that the Chapter 2 in Physical Science- 'Is Matter around us Pure' has to be sequenced after Chapter 3 'i.e. Atoms and Molecules'. Some teachers also felt that the Class VIII Science book and Class IX Science book are not linked. Such as 'light' and 'electricity' chapters are in Class VIII, but not in Class IX and again it appears in Class X. A few teachers expressed that the concepts such as 'valency' had not been included in the current textbook; which is required for writing chemical formulas in Chapter 3.

Almost all (50 out of 51) the teachers said that the activities given in the book are sufficient but they are unable to conduct the activities and experiments in the class due to large number of students in the class and inadequate space for conducting activities. Some of the teachers added that materials available are not sufficient for providing opportunity to all the students to conduct the experiments. Only 11 (21.56%) teachers felt there is a need for more examples. They also added that more explanation and simple examples are needed for the chapter 'Gravitation'. The chapter 'Motion' especially the graphs explained for derivation of equations of motion are difficult for students to understand as expressed by 55 percent teachers. The other difficult concepts are Newton's Laws of Motion, Atoms and Molecules, Atomic Structure, Propagation of Waves in the chapter 'Sound' and Gravitation. Many teachers (36.53%) expressed that 'Tissue system' is difficult for the students to comprehend due to heavy theoretical discussion in the chapter. All the teachers expressed their concern about numerical problems being difficult in all the chapters for the students.

During the Focus Group Discussion with the students, when they were asked to specify the difficult areas in Science, students expressed that the technical terms and formulae in Science were difficult for them to understand and/or remember particularly in units such as 'Bio-diversity', 'Sound', 'Tissue' , 'Motion' etc. They articulated that *"We are able to understand these topics in class but cannot remember after some days"*. The concepts which involve more thinking or solving numerical problems or extrapolation of facts are more difficult for students to understand. However, they find the topics which give emphasis on memory or lower order thinking easy.

Analysis of pedagogical processes in Science at Secondary Schools of Odisha with respect to pedagogic strategies adopted

Quality of school learning is largely dependent on the pedagogical practices being conducted in the classroom. The basic pedagogical practices followed for classroom transactions include planning the lesson for attaining the defined learning objectives, sequencing the activities depending on the arrangement of concepts, adopting appropriate teaching learning methods enhancing the learners' active involvement and participation, use of appropriate and contextual resource materials, using learners' experiences and involving them in argumentation, observation and experimentation. The data obtained by using Classroom Observation Schedule and interview with Science teachers are analysed to study the pedagogical strategies employed in the Science classrooms. The frequency and percentages of each category of observed

data are mentioned below in the table 1.2.

Table 1.2: Analysis of pedagogical process with respect to pedagogical strategies as observed in the classroom (N=51)

Items	Yes (in percentage)	Partially (in percentage)	No (in percentage)
Provided situation to think over	7.8	33.3	58.8
Directly stated the topic	58.8	3.9	37.3
Focussing only on textbook	47.1	49	3.9
Appropriate methodology according to the content	27.5	45.1	27.5
Appropriate methodology according to the level of the learner	19.6	49	31.4
Items	**Often (in percentage)**	**Sometimes (in percentage)**	**Never (in percentage)**
Encouraged students questioning	7.8	17.6	74.5
Promoted Observation	13.7	29.4	56.9
Promoted Argumentation	2	19.6	78.4
Promoted Analysis	21.6	45.1	33.3
Promoted Experimentation	5.9	7.8	86.3

It is clear from the table that 59% of the classes did not provide situations for students to think. The teacher directly stated the topic without linking students' previous knowledge in the same percentage classes. It is observed that 47% of the classes focussed only on the text book. In less than 50 % classes, the methodology was found appropriate with respect to content and level of learners (45% and 49% respectively). In most of the classes lecture method, and discussion method was followed. It was also seen that some teachers read out line by line from the textbook and then lectured the same. The experiments were explained by drawing diagrams on the blackboard. Some of the teachers were seen dictating important points in the class. More than 75% of the teachers did not encourage students to either question or involve them in argumentation in the class. Observation was not promoted in more than fifty percent classes. Only 22% of the teachers promoted analysis in the classroom where as opportunity for experimentation was very rare (6%). Attempt to develop thinking process, questioning ability, observation, argumentation and experimentations of the learners was rare.

Interview with the teachers also presented similar findings. Teachers responded that they were following the demonstration method and other traditional methods. 86% teachers were not conducting experiments and activities with students-while teaching and 70.58% teachers said that they were using the demonstration method for teaching Science. Teachers were mostly busy in completing of the syllabus rather than following innovative and modern methods of teaching. Students were not performing any experiments or activities in the classroom. However, focus group discussion with the students revealed that in 45% (23) of the schools, teachers do demonstrate a few experiments in class. They also expressed that most of the experiments were explained by drawing diagrams on the blackboard. Others were using the lecture cum discussion method. But during observation only 5.9% of the teachers demonstrated experiments in class and 86.3% of the teachers had not conducted any experiment. Only 13.7% teachers provided opportunity for promoting observation among students. Explanation of concepts was mainly accompanied with

examples. Most of the teachers appreciated the 5E learning cycle; they expressed that "*though it was suggested to use the 5E model for teaching Science but we are not able to do this due to large number of students in the class or due to lack of time.*" A few teachers didn't specify the method they use, rather expressed that they use the methods according to the requirement of the topic. While answering the item on type of opportunities provided to the students for activities and experimentation, most of the teachers talked about demonstrating the experiments in class. Except a few, they also said that students do not perform any experiment in class. Most of the teachers expressed that they give examples to relate the content to day to day life. Only one of the teachers from Sambalpur said that learners are provided with projects to complement classroom learning. Students are of the view that they are not able to understand some difficult concepts in Science as they find the method not very interesting. They are not giving opportunity to perform certain activities and experiments either in the school or at home, except a few. In few schools, students expressed that "*the teacher asked us to do small observations at home. For example we were asked to observe germination of seed at home and we have also done the experiment.*" Numerical problems associated with Science content mostly in Physical Science are difficult for the students. Teachers did not solve numerical problems frequently and such problems were given as homework. Because of lack of practice in solving the problems, students found the problems difficult to solve.

Analysis of pedagogical processes in Science existing at Secondary schools of Odisha with respect to resource management

Resource management is a skill of making full use of the available resources to make the students understand and learn about any content. These resources include the Science laboratory, Science kit, Resources created or developed by teachers and students, ICT resources, Availability of library resources in Science, Reference materials used by teachers, Adequacy of materials and frequency of use of the materials. Proper managing of these available resources can enhance students' learning to a greater extent. The frequency and percentages of each category of the observed data are mentioned below in the table 1.3.

Table: 1.3: Pedagogical Processes in Science with respect to Resource Management (N= 51)

Items	Often f (%)	Sometimes f (%)	Never f (%)
Uses appropriate resources in the class	4 (7.8)	9 (15.7)	39 (76.5)
Integrated technology resources in Science teaching	2 (3.9)	2 (3.9)	47 (92.2)

It is indicated in the table that the use of appropriate resources in the class and integration of technology resources in Science teaching is 8% and 4% respectively which is negligible. Useof technology in the classes was delimited to displaying some pictures on the mobile while teaching 'Cell' by only two teachers. Most of the classes had neither used appropriate resources (77%) nor integrated technology in Science teaching (93%). Few teachers used charts while teaching but the use of locally available resources were not observed anywhere except by one teacher at Ganjam district while teaching 'Sound'.

It is found from the above analysis that except a few, Science teachers teach without appropriate resources which is an essential aspect of Science teaching. Very few teachers are using charts, lab equipment and ICT for teaching Science. It may be noted that all the govt. schools have been provided with a projector, a Knowledge Yantra (KYN) machine which is preloaded with the videos for all the chapters of Science. In the interview, teachers

claimed that they use charts, lab equipments, and ICT lab for teaching Science. One of the teachers expressed "*I used to display some videos by downloading from YouTube*." Most of the teachers expressed that lab materials are used mainly for teaching Physical Science whereas charts are used for teaching concepts such as tissues, plant cells, animal cells etc. and models of the eye and ear in Biological Science. But most of them were not doing any experiments involving chemicals in the class due to safety issue.In some schools the chemicals were outdated and not in a usable condition. In most of the schools labs were managed well and materials were kept in an unorganized way in a room called Science room. Nowhere in the observed schools, the students were going to the Science lab for doing experiments. Students expressed that teachers bring some materials to class not so frequently and demonstrate; however students were strictly not allowed to touch any material in most of the schools. That means, the materials have been used, though not frequently but for teachers' demonstration purpose only. But the discussion with the students revealed that they were highly interested in doing experiments in the Science laboratory. They also expressed that no learning resources were prepared from the immediate environment. Most of the teachers expressed that they involved the students in competitions on Science exhibitions, Science quiz, projects etc. However, on a daily basis, no activities were conducted in Science classes in most of the schools. All the teachers appreciated activity based learning in Science and demanded well-equipped laboratory in the schools. They also revealed that charts were the most extensively used learning resource, that too supplied by the Government, not self-developed.

By analysing the Science laboratory checklist it was found that in most of the schools the equipments given in the Science kit were available. However, the number of equipments available were not adequate for involving the students. In some old schools, the equipments available were outdated and not required according to the present course of study. In around 30% of the schools, the equipments-were properly maintained and utilised by the students which is revealed by the triangulation of the data collected from the teacher and students. In almost all the schools, essential chemicals were not available. It was found that the Science labs in most of the schools were not properly maintained. In most cases the equipments-were dumped in the cupboard. There were a few schools where well equipped laboratories were available; however, rarely it integrated in the teaching-learning process. The video supplied by the government had been shown to students occasionally and all the teachers appreciated those videos. They expressed that videos had to be prepared more in number covering all the concepts and supplied to the teachers. It indicates that they are neither aware of e-content process nor teacher's role in its development.

Analysis of Pedagogical processes in Science with respect to Assessment

The learners' assessment is analysed with respect to the strategies followed- oral, written or performance wise; self and peer assessment, Continuous assessment, provision for follow up and feedback. The frequency and percentages of each category of the observed data are mentioned below in the table 1.4 followed by qualitative analysis of interview and FGD data.

Table 1.4: Pedagogical processes in Science existing with respect to assessment

Items	Often f (%)	Sometimes f (%)	Never f (%)
Focusing upon right or wrong response	46 (90.2)	3 (5.9)	2 (3.9)
Pose questions even on right or wrong	3 (5.9)	19 (37.3)	29 (56.9)

Informal assessment procedures used during the lesson	27 (52.9)	21 (41.2)	3 (5.9)
Items	Yes f (%)	Partially f (%)	No f (%)
Provided scope for peer and self-assessment during the lesson	3 (5.9)	5 (9.8)	43 (84.3)
Providing feedback after assessment	1 (2)	10 (19.6)	40 (78.4)
Items	Yes f (%)	Partially f (%)	No f (%)
Assessment was done at the beginning of the lesson	38 (74.5)	13 (25.5)	
Assessment was continuous	29 (56.9)	21 (43.1)	
Items	Oral f (%)	Written f (%)	Performance f (%)
Mode of assessment	42 (82.4)	9 (17.6)	0

The table reveals that in 90.0% of the classes, assessment has been done in the class focussing only on right or wrong response, 57% teachers did not pose questions even on right or wrong responses. Informal assessment is done mostly during the lesson. There was no scope for peer and self – assessment during the lesson (84%). There is almost no feedback provided after assessment (78%). There was continuous assessment of learners during the lessons (57%). The assessment was done mostly in the [82%] oral mode.

A glance at the analysis shows that during the assessment, focus was on right and wrong answers. Informal oral assessment was done during the class. There was no scope for self or peer assessment and feedback after assessment. The teachers informed that there was 4-6 formative assessments conducted in terms of unit test and two summative assessments i.e. one half yearly examination and one annual exam. All the exams were in the form of written exam in all the schools. There was no scope for peer and self-assessment. The result after assessment was reported to the students through a report card. One teacher at Keonjhar district said "*I motivate the students personally to improve their performance by giving appreciation. But I am not able to organise any extra remedial class for them.*" Others also said that they could not take further steps to improve the students' standard. The students also revealed that a unit test, one half yearly test and one annual examination was conducted in the schools regularly. These answer sheets were valued and reported to parents in time for feedback. No feedback was obtained either from the parents or from the teacher.

Major Findings

The major findings of the study are

1. The teacher assess previous knowledge of the students before teaching a new lesson in the class through a few questions.
2. Sequencing the content of the lesson was mostly done properly.
3. Content with real life situation were sparingly correlated in the class, however teachers sometimes give examplesbeyond the textbook.
4. The teachers were not raising any HOT question while teaching in class.
5. The teachers find it difficult to conduct activities and experiments due to large number of students in the class or unavailability of functional equipments.
6. The school laboratories are not well equipped with TLMs, models, charts,

equipments, chemicals, specimens for use of the students.

7. The teachers are not utilising community resources or resources of the neighbourhood for teaching Science in the class.
8. Most of the teachers are giving importance to the content, examples and activities given in the textbook and not going beyond the textbook.
9. Appropriate methodology was not followed according to the content and level of the learner.
10. The teachers rarely encourage students to raise questions in the class, promote observation, argumentation, analytic power, higher order thinking skills and experimental skills.
11. Students face difficulties in understanding some units in Physical Science and solving numerical problems in Physical Science.
12. Teachers are not conducting any individual and group activities for learning Science.
13. In the class during teaching, the teacher assesses through mainly knowledge type questions and higher ability questions are neglected.
14. In almost all the schools, 4 unit tests and two terminal tests have been conducted regularly and results are communicated to the parents but no feedback is taken from the parents or from other teachers for the improvement of learning Science.

Discussion

The study was an attempt to examine the pedagogical processes in Science with specific reference to content, pedagogical strategies employed, resource management and assessment. It is found that conventional method of teaching was mainly followed in Science classrooms with less or no variation among schools. This finding is in agreement with that of Karamustafaoglu, Bayar and Kaya (2014) who found that the teachers preferred to employ traditional, teaching methods in Turkey. It is clearly evident that non-traditional teaching methods based on student centred discussion, laboratory practices, role playing and project-based learning etc. are lacking in the pedagogical practices in Science in government secondary schools of Odisha. The study conducted by OMSA (2016) also supports the finding that laboratories were not used regularly in the schools in Odisha. The study found that no group activities were conducted in Science classes. It was also found in the OMSA study that the rural schools possess inadequate space for group work. However, in a study conducted by Stroupe (2017), he concluded that a teacher's pedagogical preparation shape how they design classrooms as a place of Science. Therefore, effort must be geared towards strengthening teachers to transform the classroom space to an effective learning space by exploring various possibilities of child centric strategies. It is interesting to understand all the teachers appreciated the learner centric, activity based classroom. However, in the name of challenges, most of the teachers appear to be less optimistic about such a classroom. Most of the time they expressed that such classes are possible when students have strong pre-requisite knowledge. Therefore, many a times very less effort has been seen in asking any Higher Order Thinking question in the classroom. Neither they had taken extra effort to revert the challenges. The processes of Science such as observation, measurement, experimentation, argumentation etc were highly ignored. No group activity could be observed in any of the classes indicate that social construction of knowledge is not appreciated well by the teachers. This might be because of their less competency in creating collaborative learning space for students and their rigid belief system about Science and Science learning. Onsite mentoring or flipped training method could be adopted to develop their confidence in organising active learning situations.

Use of Science laboratories as learning resources is highly neglected in most of the schools. This finding is in agreement with

that of Zengele and Alemayehu (2016) who studied the status of Secondary School Science laboratory activities in case of Wolaita Zone, Southern Ethiopia and found that status of laboratory works in secondary schools is in a very low level where Science teaching learning process is not supported adequately by laboratory works. The most determinant constraints of laboratory activities in secondary schools include lack of laboratory rooms, inadequate supply of lab equipment and facilities, absence of trained laboratory assistants/teachers, lack of commitment and interest of teachers and lack of regular schedule for laboratory activities. Considering the conclusions by Hofstein and Lunetta (1982) when suitable activities are used in laboratories then effective development and promotion of logic, inquiry and skills for problem-solving might occur, focused initiatives are required from the Government to supply and provide suitable laboratory materials to each school. Teachers have not received specific capacity development programmes to integrate laboratory activities for quality Science education. Their confidence in handling a laboratory may help them to overcome the challenges and be more committed to develop improvised material and enrich laboratories in their respective schools.

Creating a healthy learning atmosphere for Science learning in schools is very significant wherein learners are motivated to explore nature in multiple ways. Unfortunately, in none of the schools, Science clubs are functional. Other pedagogic activities are delimited only to sending a few children to Science exhibition or Science quizzes, etc. However, most of the children are not part of these activities. The pedagogical processes in Science in Odisha doesn't give a very colourful picture. However, a few individual level initiatives had been seen. In very few cases, it is found that amongst the challenges, a few teachers try to make a difference in Science learning processes though the number is very few.

Multiple ways could be suggested to make a change in the process of learning Science, however, the initiatives suggested could be based on 'subjective reality' of teachers as well. It might not be conducive if teachers are considered as solely responsible for the not so good scenario of Science education. The overall learning environment in schools has to be improved by providing necessary facilities. Teachers should not be deputed for other official duties. Support system has to be strong enough to motivate teachers to make a change in the system by providing quality Science learning opportunities to students.

Educational Implications

The above findings reveal that Science is taught in our school as a traditional subject and follows a traditional pattern of teaching. Due to the demand of the society, in the context of national development, Science is considered as a core subject in the school curriculum. If Science learning is not properly facilitated in the schools and does not adopt a modern pedagogy there is a possibility of rote learning only the product aspects of Science-facts, concepts, laws, theories etc. Greater involvement of teachers and their commitment to the profession may lead to better planning of the lesson. In the process of planning, designing and developing pedagogical strategies, reflection of teachers is very significant. Therefore, effort has to be made to transform teachers from just being a 'transmitter of knowledge' into 'reflective practitioner'. For that, on-site support and mentoring has to be organised. Decentralised training programmes may help teachers to monitor their own professional practices and take well-informed decisions about pedagogical processes. More field based trainings must be organised to bring changes in the pedagogy. Since isolation of schools from community are felt, more involvement of community in pedagogical processes are to be brought in. Symbiotic relation between community and school could be appreciated. Government should take necessary steps to provide sufficient laboratory resources and materials so that activity based classrooms

could be encouraged. Teachers should work with students to prepare low cost improvised apparatus or materials and enrich Science laboratories. Initiatives are to be taken for preparing teachers to integrate ICT resources into the teaching-learning process. Teachers have to be oriented to develop e-content materials rather than solely depending on the readymade videos supplied by Government. Assessment system has to be more robust. There should be some bridge programme to improve the performance of students in Science. In addition, Science clubs and other learning resources are to be functional for developing scientific temper and motivate students to be responsible citizens of the country.

Conclusion

On the basis of the above findings, it is clear that the teachers are mostly adopting traditional methods of teaching Science. The observed classes are teacher dominated classrooms where teachers are not facilitated to ask questions, providing situation to think highly and following the methodology as per the convenience of the teachers. Students are not encouraged to develop their science process skills. The traditional strategies of teaching Science at school such as memorisation, textbook method, textbook reading and Science teaching without activities and experimentation were followed in the school. This is the most prominent issue of Science teaching in government secondary schools of Odisha and efforts are to be taken to revamp pedagogical processes in Science.

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