PROBLEM SOLVING USING SELF-GENERATED DATA: LEARNING CONCEPT OF SPEED AT UPPER PRIMARY STAGE

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Abstract

Working on self-generated data contextualizes learning and students see relevance of their learning in their day-to-day life. An attempt has been made to examine, 'can solving problems using self- generated data by performing activities facilitate students at upper primary stage to learn concept of speed in better way?' It is observed that this approach can bridge the gap between their classroom experiences and everyday life experiences and remove fear of solving numerical problems. The study highlights the importance of actively engaging the students in the construction of knowledge and learning scientific concepts by self-generated data. Teaching-learning of science needs to be transformed from the process of knowledge transfer to knowledge generation.

Keywords: Self-generated data, Problem solving, Numerical problems, Speed

Introduction

At the upper primary stage the children are getting their first exposure to 'Science'. This then is the time to bring home the right perspective of what it means to 'do science' (NCERT, 2006a). During upper primary stage (6-8) we can expect the beginning of quantitative understanding of the world (NCERT, 2006b). One of the goals of science education and, in particular, Physics Research (PER) worldwide is "teaching students to solve problems" (Harskamp & Ding, 2006; UNESCO, 2004; Sabella and Redish, 2007).Solving problems is essential part of teaching-learning of science. It includes analysis (taking apart the ideas/components involved in the problem), synthesis (putting the idea/ component about the problem together) and evaluation of situation in the context. In problem solving approach, teacher facilitates students in identifying the problem. For this, s/he may create a situation, pose a question, perform activity or experiment, elicit inquiry from students to make students realize that a problem exists and help them to identify the problem (NCERT, 2013). As Barrows and Tamblyn (1980) note, in problem based learning 'the learning results from the process of working towards the understanding or resolution of a problem. The problem is encountered first in the learning process, rather than facts, models, conceptual frameworks, or other information. The problem serves as a stimulus and focus for problem solving and learning'. By weaving thinking patterns of different steps of the solution of the problem with the help of learners, problem solving performance and conceptual networks pertaining to principles of physics can be strengthened (Prabha,2006).

Some have said that in problem based learning, the teacher moves from being a 'sage on the stage' to being a 'guide on the side' (Wilkerson et al., 1996). From the constructivist view of learning, knowledge is "temporary, developmental, non-objective, internally constructed, and socially and culturally mediated. Learning from this perspective is viewed as a self-regulatory process of struggling with the conflict between existing personal models of the world and discrepant new insights, constructing new representations and models of reality as a human meaning-making venture with culturally developed tools and symbols, and further negotiating such meaning through cooperative social activity, discourse and debates" (Fosnot, 1996). The problem solving approach also values first-hand student interaction with materials so as to ensure active processing of ideas (Martens, 1992).

Proponents of the new approaches to teaching engage students in a variety of different activities for constructing a knowledge base in subject domain. Such approaches involve both a set of facts and clearly defined principles. The teachers' goal is to develop students' understanding of a given topic, as well as to help them develop into independent and thoughtful problem solvers. One way to do this is by showing students that they already have relevant knowledge. As students work through different problems that a teacher presents, they develop their understanding into principles that govern the topic (Bransford, J.D.et al., 2000).

Context of the study

Students should be involved in teaching-learning process as active participants, not as receiver of a fixed body of knowledge. Regarding designing learning experiences NCF -2005(NCERT,2005) observes, "By the time children reach class VII, many children who have grown up in this kind of learning environment lose their self-confidence and their ability to express themselves or make meaning out of their experiences in school. They repeatedly resort to mechanical rote memorization to pass examination". Here this kind of learning environment refers to the situation where children are passive receivers of knowledge created by others and where they learn not to value their own ability to think and reason.

Learning of the new concepts requires relating and familiarization with the existing mental framework of the students which are very diverse (Prabha, 2004). One the guiding principle of NCF-2005 is linking life at school with student's life outside the school. Learning is enriched if existing ideas of students are used as the starting point of teaching-learning process; their changing conceptions are monitored throughout this process by relating their personal experiences to teaching-learning experiences. In this way, students remain engaged in learning the concepts of science.

It is well known that scientific concepts, inherently abstract due to their universality, can seem to be completely disconnected from everyday life, especially when taught to school children outside of context of their applicability (Fleer, 2009). The solution lies in application of inquiry-based learning. Inquiry teaching and learning is both hands-on and minds-on. It is hands-on because it involves pursuing experiments, manipulating materials, answering questions, and working cooperatively. It is minds-on because it requires active student thinking, problem solving, analysis of information, and making meaningful connections to everyday life (Benedis-Grab et al., 2009). Making meaning, reflecting and abstract thinking are important aspects of learning. Students at upper primary stage can understand abstract concepts if it is supported by concrete experiences.

The use of problem-solving in science instruction implies a change in the teacher's role from dispensing content information to encouraging critical reflective thinking in the student (Chine, Christine, 1994). In particular, as stated by UNESCO (2004), science education should encourage and develop both a scientific culture and the ability to solve problems, and Garret (1987) points out that there is a long and widely held belief that solving problems is a fundamental scientific activity, which differentiates it from other human activities. The author argues that the process of solving problems goes beyond the scientific field since it touches on other areas of life at individual and social levels, and can be considered as an expression of the development of creative thinking.

Problem based learning and activities based learning are students centred approaches. Therefore, encouraging students to ask question, perform activities, observe carefully, identify problem, record observations and interpret the data (not necessarily in the same order) to solve problems can help them to construct their knowledge in science. Learning to solve problems facilitates understanding concepts of science and linkages among them. However, it is observed that students at upper primary stage are not enthusiastic to solve numerical problems and do not take initiative in this regard. Therefore, a need is felt to design some innovative learning experiences helping them to relate the concept of speed with their everyday life experiences. The present study is carried out in the above backdrop. An attempt has been made to investigate whether encouraging students at upper primary stage to solve problems from self-generated data by performing activities help them in learning concepts of speed.

Research design

Objective

- Student will generate data themselves by performing activities based on the concept of speed.
- Students will identify and solve problems based on the concepts of speed using self generated data.
- They will apply their understanding about concepts of speed to explain and to solve problems in novel situations.

Hypothesis

- There will be significant difference in the students' achievement in the concept of speed if they learn it through problem solving using self-generated data than through traditional approach.
- There will not be significant difference in the students' achievement in the concept of speed if they learn it through problem solving using self-generated data than through traditional approach.

Sample

A semi-urban village school under an autonomous organisation was the field area for the study. The school was fully residential, co-educational and CBSE affiliated. For the purpose of this study class VII was chosen.66 numbers of class VII students participated in the study. Control group and experimental group design was chosen for the present study. Table 1 shows the study design.

Table 1: Design of the Study

Control group			Experimental group		
G_1	T_1	01	G_2	T_2	02
G_1 – Control group T_1 – Teaching learning through traditional approach 01– Test for control group			G_2 –Experimental group T_2 – Teaching learning through problem solving using self-generated data by performing activity 02 – Test for experimental group		

Table 2: Sample of the Study

Name of Group →	Control group			Experimental group		
Sex →	B	G	Total N	B	G	Total N
No. of participants →	14	18	32	16	18	34

Data Collection

Classroom observation, students' record in their journals and achievement tests were used to collect the data. Students of the experimental group were given opportunities to share their ideas and efforts were made to elicit their thinking by maintaining the classroom environment conducive to discussion. Similar data for the control group was collected by teaching through traditional approach.

Method

First of all a context related with the concept of speed was created by integrating real life experiences of students. Questions regarding their everyday observations were asked. A student was having the idea that the vehicle having bigger wheel will move faster than the vehicle having smaller wheel. He was suggested to give argument supporting his idea. On asking, "can a bullock cart move faster than a car, he was puzzled. Some students were having idea that motorcycle moves fastest of all vehicles on the road. Investigator listened to them without being judgmental. The class identified the problems, how do we measure speed of a moving object and what does it mean when we talk of speed of an object. The class was facilitated to perform the activity in a group of six students.

The investigator engaged the class in doing following activity. A line was marked with a chalk on the classroom floor. A toy bus, a golf ball and a discharged pencil cell were placed on this line. Investigator suggested them to predict which of the three objects would travel largest distance if they were pushed simultaneously by a wooden scale? Which of the three objects would move fastest? 20% of the students were of opinion that the bus would cover the largest distance and it would move fastest. They were asked to give justification of their responses. They were relating the speed of the toy bus with actual bus they observed in their everyday life. 80% of students predicted the ball would move fastest. There was a discussion amongst students over this difference in opinion. They were eager to verify their ideas.

After giving signal by a student, the objects were pushed simultaneously by another student with the help of a wooden scale. Distance covered by the three objects was measured by a metre scale and time taken to cover the distance was measured by three students using timer of mobile phones. Opportunity was provided to all students of the class to perform and repeat the activity which they enjoyed.

Investigator facilitated the students to recall unitary method of solving numerical problems. They were also facilitated to conceptualize that the distance moved by an object in a unit time is called its speed and speed of objects helps us to decide which one is moving faster than the other. Students realized that they had to measure distance and time to calculate speed. Students recorded their observations in their journal. They calculated speed of the three objects and concluded on their own that the ball moved fastest. They were facilitated to evaluate their predictions in the light of their observations. They recorded their observations and figure of the activity in their journals.

Second activity was given as an assignment to the class in order to reinforce those concepts. Also, idea was to help them appreciate that distance between two places can be determined if time and speed are given. Few questions were asked to them, ‘all of you stay in the some hostel (since, school was fully residential)? All of you reach the classroom in the morning at the same time? How do you know who is moving fastest? Do you want to know the distance between your hostel room and the classroom? Would you like to calculate this distance on your own? There were very lively interactions in the class with narration of their personal experiences regarding those questions. Students were suggested to record the time taken by them to reach the classroom from their respective hostel rooms by using their watch. This activity was performed the very next day. They were asked to find the distance covered by them in their measured time. It was given that roughly, walking speed of humans is 1.4 m/s. They calculated the distance in metre, since hostels were situated in the school campus itself.

The class was then facilitated to solve the numerical problems based on the concepts of speed. Various concepts given in the chapter *Motion and Time* of the NCERT Class VII Textbook were discussed by connecting with their personal experiences. Many questions starting with, ‘What do you think about…?’;‘What does it mean to you…?’; ‘How does it relate with your experiences?’; ‘What question you want to ask?’ ;‘What is your idea about…?’ were asked to them to help them reflect on their learning. Students were allowed to ask questions freely and to engage in dialogue with peers and the investigators throughout the study.

An achievement test comprising five questions was given to the class after finishing the chapter. Out of five, three items comprised numerical problems and two items were for assessing conceptual understanding regarding *speed.* A similar test was given to the control group after teaching the same concept through traditional approach.

Thus, a six stage framework was designed to facilitate students to work on problems in science through self-generated data (*Figure-1)*.

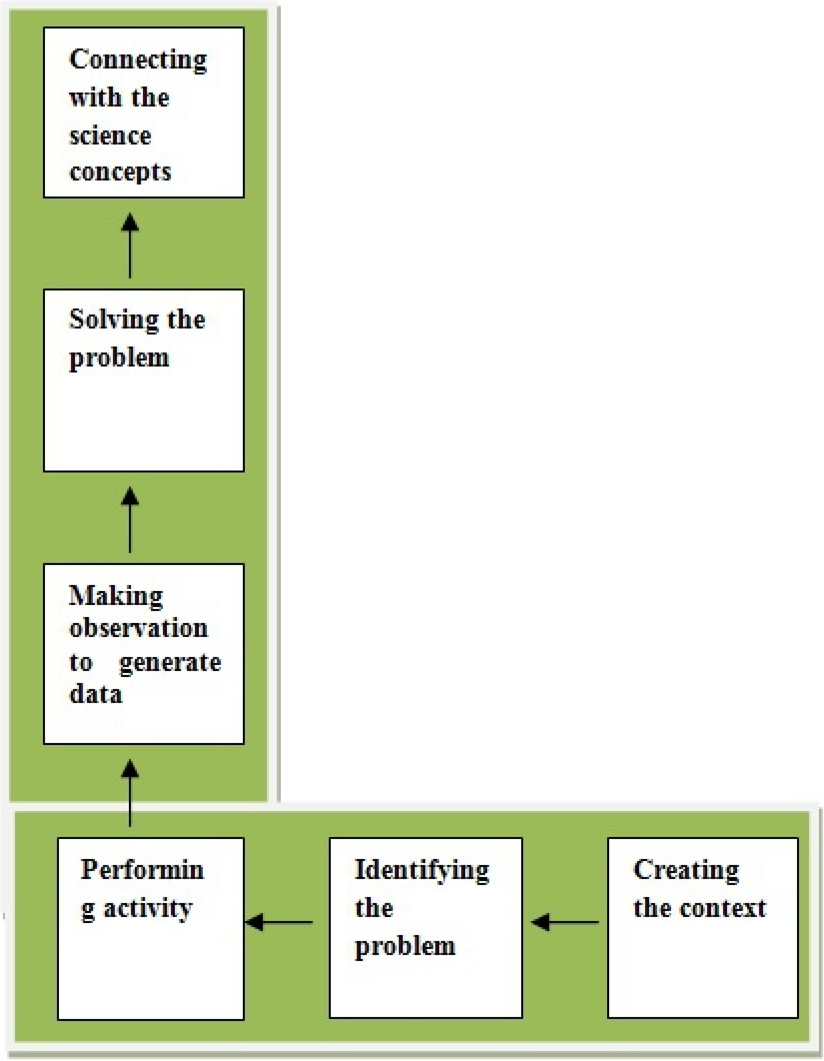

Figure 1:- Six stage framework to work on problems in science through self-generated data

Findings and Discussion

Students' record of activities in their journal was observed. Test scores of both control group and experimental groups were analysed and their mean and standard deviation were calculated. Unpaired form of the't' test was used for analyzing the data. Table-3 shows performance of control group and experimental group. The mean score of control group is 17.16 and that of experimental group are 19.42 respectively (*Figure 2*).

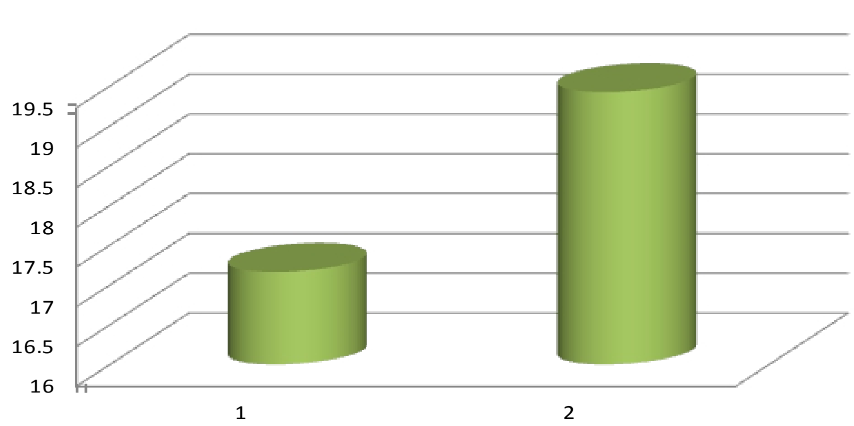

Fig.-2: Showing Mean scores of achievement of control group ($G1$) and experiment group (G_2)

Experimental group mean score is higher as compared to mean score of the control group meaning thereby that students learn the concept of speed in better way if they learn it through problem solving using self-generated data than through traditional approach. The maximum possible score on achievement test is 25. It is found that Standard Deviation (S.D.) of control group and experimental group are 4.41 and 2.44 respectively (**Table -3**).

Table-3 Mean scores and S.D. of the control group and experimental group

Groups	N	M	S.D.	‘t’
Control G_1	32	17.16	4.41	2.5778*
Experimental G_2	34	19.42	2.44	

*Significant at 0.05 level

Table-3 also reveals that there is a significant difference in students’ achievement in the concept of speed if they learn it through problem solving using self-generated data than through traditional approach at 0.05 level of significance (t=2.5778).Therefore, null hypothesis is rejected. It may be concluded that the new approach of teaching-learning situation affects the students’ performance in the test.

Students got opportunities to activity construct their knowledge about concepts of speed by visualizing the situation, doing activity in everyday life situation, thinking and arriving at conclusion on their own. They noted down the known quantity and were able to identify the unknown quantity for solving the problem. They were self- motivated to determine the unknown quantity. They could apply their understanding of concepts of speed to solve problems in novel situations as was observed from the achievement test. This approach of teaching-learning also encouraged more interaction among students.

The study throws light on the effectiveness of using self-generated data for problem solving and learning the concept of speed at upper primary stage.

Conclusion

Although sample size of the present study is small, it highlights the importance of actively engaging the students in the construction of knowledge and learning the scientific concepts by self-generated data. Teachers need to facilitate students to see relevance of the science concepts learnt in the classroom in their everyday life. Students should know not only "how to solve problems" but also they must learn to explore "how do we know what we know". Understanding concepts of speed through solving problems from self- generated data by performing activity gives students ownership to their learning which is revealed by their enthusiasm in participation in the teaching-learning process. Helping students at upper primary stage to learn problem solving by self-general data can bridge the gap between their classroom experiences and everyday life experiences and remove fear of solving numerical problems in science. Contextualizing makes ideas more accessible to them as they get actively engaged in learning. Students learn to construct evidence based explanations based on their observations.

We need to develop more confidence in students' ability to learn independently and to change in how we think of them and the process of learning in students centered pedagogy perspective. Students should be encouraged to gather considerable data before drawing conclusion in the process of learning scientific concepts.Teacher should provide them opportunities to make meaningful connections of their learning with their everyday life experiences.

Problem solving should be taken as integral part of teaching-learning of science, not as an add-on task. Emphasis should be given on construction of knowledge by performing activities, identifying and solving problems rather than solving textbook exercise problems using algorithm without understanding the inherent concepts; learning by doing rather than learning by listening. Active engagement in learning can lead students to better understanding for active use of their knowledge.

At upper primary stage, it is suggested that wherever possible, students should be encouraged to carry out activities to generate data for solving numerical problems. Obviously, it is not feasible to learn problem solving of all concepts in science at all stages using self-generated data. Analyzing the curriculum of science at various stages of learning, such concepts can be identified and innovative strategies having space for actively involving students can be used. No rigid procedure can be prescribed in designing teaching-learning situation in students centered approach. Teachers should feel themselves empowered to design innovative learning situations for students, going beyond the textbook and going beyond the classroom. Teaching-learning of science needs to be transformed from the process of knowledge transfer to knowledge generation that is central to problem solving skills and making students autonomous learners.

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