An Investigation into Students' Understanding about the Concepts of Energy at Senior Secondary Level

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Abstract- *Present study entitled "An Investigation into Students' Understanding about the Concepts of Energy at Senior Secondary Level" was conducted on senior secondary students of a Government School. Students were divided into two groups namely, experimental and controlled to investigate their understanding about the concepts of energy. Analysis of the students' responses clearly revealed a significant difference between students' understanding of experimental and controlled groups about the concepts of energy. The same was attributed due to the constructivist approach of teaching learning.*

Keywords: Concepts of Energy, Constructivist Approach and Teaching Learning Process.

Introduction

Constructivist approach of learning has got enormous focus in the physics education over the past thirty years. In this approach, students construct their own knowledge of the world through experiencing things and reflecting on those experiences (www.ncert.nic.in). In present scenario learning emphasizes on the processes (www.ehow.com/info_8634178, Ausubel D. 1978, Fosnot V. 1996, Barufaldi J. 2002, Evangelista T. 2002). The key role of teacher is to create environment in which students interact meaningfully with teaching learning materials/resources nurturing the learning processes and act as a facilitator (www.ncert.nic.in, www.ehow.com/info_8634178, Ausubel D. 1978, Fosnot V. 1996, Barufaldi J. 2002, Evangelista T. 2002, Sharma S. V. 2004 and Sharma K.C., Sharma S. V. and Sharma K.C. 2005, Carroll D. R. 2006). Teaching learning about the concepts of physics such as energy can be made joyful and fruitful activity through constructivist approach. Constructivist approach engages the students in acquiring methods and processes that nurture their curiosity and creativity. Teaching learning the concepts of physics is characterized by focused emphasis on processes namely minute and careful observations, sensing of problems, literature survey/consulting teachers or and peer group members/friends, identification of a particular problem, experimentation for seeking solution, data collection, analysis and interpretation of data, drawing inferences, testing and modifying the hypotheses and scope for further studies (www.ncert.nic.in, www.ehow.com/info_8634178, Ausubel D., 1978, Fosnot V., 1996, Barufaldi J., 2002, Evangelista T., 2002, Sharma S. V. and Sharma K.C., 2004).

Present study is related with the students' understanding about the concepts of energy at senior secondary level. Concepts of energy are very fundamental in physics. Its effects are distinctly perceptible in every branch of physics. Energy has a basic role in almost every scientific phenomenon. One begins experiencing energy from an early age in life. A student of science begins formal learning about the concepts of energy from elementary level yet conceptual clarity eludes many for a quite long time (www.ehow.com/info_8634178, Ausubel D., 1978, Fosnot V., 1996, Barufaldi J., 2002, Evangelista T., 2002, Sharma S. V., 2004 and Sharma K.C., Sharma S. V. and Sharma K.C., 2005, Carroll D. R., 2006, Textbook of Physics for class XI, NCERT 2006, Sharma S. V., 2007, Sharma S. V. et al, 2007, Sharma S. V., 2007-08). In the present study investigations were carried out on students of two groups namely experimental and controlled to investigate the students' understanding about the concepts of energy at senior secondary level. It was imagined while conducting the study that there is no significant difference between the understanding of students of experimental and controlled groups about the concepts of energy.

Methodology

Present study was conducted on senior secondary students of a Government Senior Secondary School, Jaipur, Rajasthan. Students were divided into two groups namely experimental and controlled. The group of students in which regular teaching learning was conducted using constructivist approach, nomenclated as experimental group and the other group in which traditional approach (Chalk and talk (lecture)) of regular teaching learning was followed nomenclated as controlled group. A total number of 46 students were in each group. Inorder to investigate conceptual understanding of the students a research tool (questionnaire) comprise of multiple choice questions related to the different concepts of energy was administered on the both groups of students. There were 20 questions in the Research tool. Research tool was prepared in Hindi as the school was Hindi medium. Open ended questions were also included in the research tool. One question was related to the concept mapping on the concepts of energy. Tool was administered simultaneously on both the groups of students. Value of 't' was calculated for students of both the groups using Data Entry: Student's 't' -Test and compared with the tabulated value (Garrett H.E. and Woodworth R.S., 2010) to see the significant difference between the understanding of the concepts of students of experimental and controlled groups. Before beginning the regular classroom teaching learning process of students of experimental group, students were asked the questions pertaining to their socio economic background, curriculum and approaches of teaching learning (S.V. Sharma, 2014). It was noticed from the classroom observations and interactions that students were very hesitant in asking questions to their teachers in the regular classroom situation. It was also noticed that the teaching learning process was unresponsive and passive in the regular classroom teaching learning process being carried out using traditional approach. Motivational and icebreaking activity session was organized to make students' friendly learning environment. Students were suggested to behave like friends and ask questions during teaching learning process. Their involvement and participation in different activities related with the teaching learning process was ensured

through group exercise, group work, quiz, seminar, project work and oral presentation of different concepts related to energy. They were also encouraged to participate in preparation and presentation of concept maps on energy. Freedom for expression of students' thoughts and interactions during the teaching learning process of the concepts of energy was appreciated. Attention was focused on the different aspects of constructivist approach (www. primaryconnections.org.au/about/teaching,www.physics.csbsju.edu/stats/test_bulk_form.html,w ww.ncert.nic.in, www. ehow.com/info_8634178, Ausubel D., 1978, Fosnot V., Catherine., 1996, Barufaldi J., 2002, Evangelista T., 2002, Sharma S. V. and Sharma K.C., 2004) such as asking open ended questions and seeking students' responses and reflections, encouraging students for higher level thinking, engagement of students in dialogue with peers and teachers, engagement of students in experiments/activities that motivate them for discussion, inquiring students about their understanding the concepts of energy. Students were facilitated to analysis and interpret the data related to concepts of energy and draw the inferences. After considering these aspects, teaching learning process of the concepts of energy of students of experimental group was commenced in the light of constructivist approach (Fig.1).

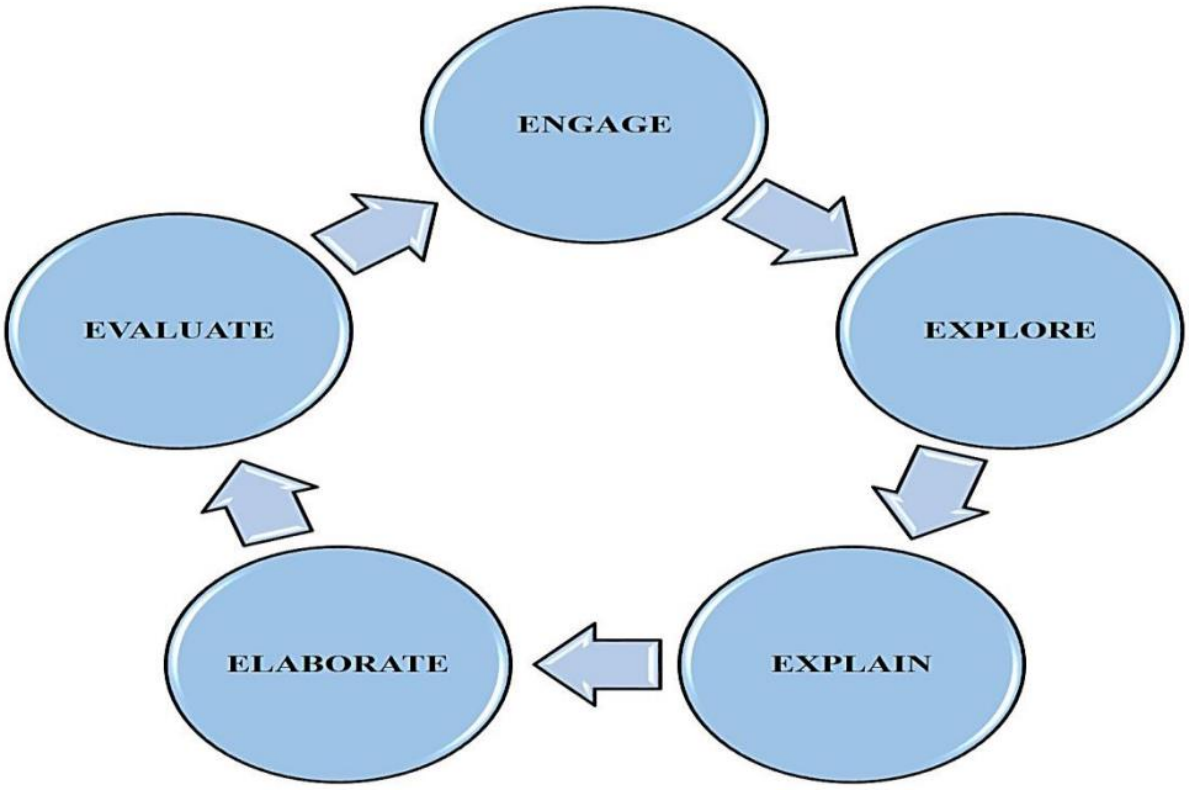


Figure 1. Phases of constructivist approach

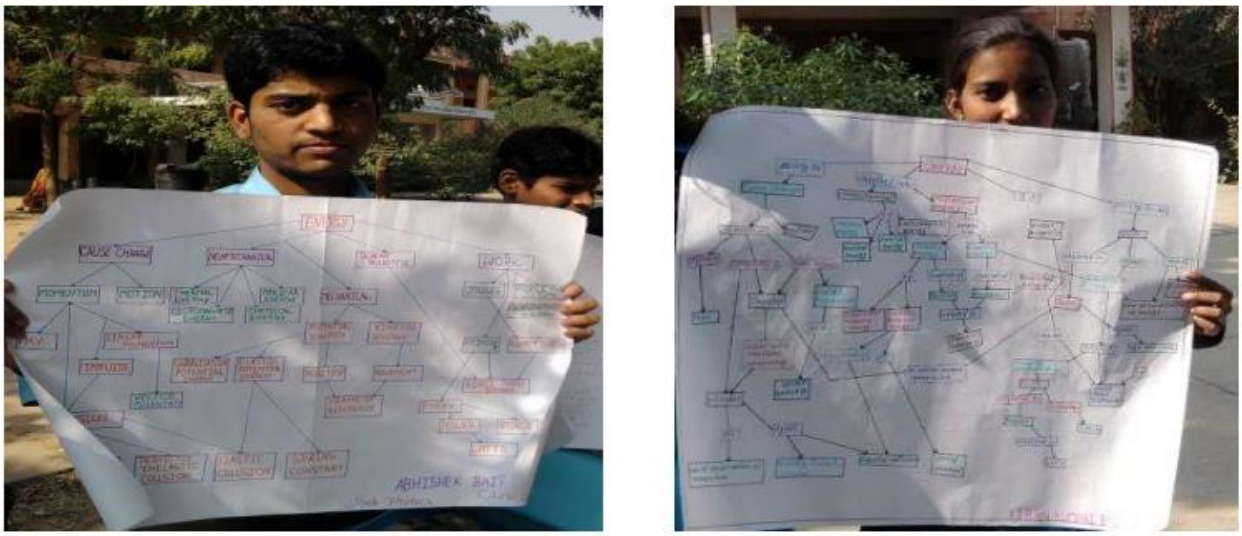
Students were also motivated to reflect, predict, infer, discuss and design activities related to the concepts of energy during teaching learning process. Students were facilitated in learning the answers of the questions related to the concepts of energy during regular teaching learning process. Students were asked to form small groups in the class to discuss and perform group

work on different concepts of energy. They were asked to summarize their discussion and consolidate the group work. After consolidation of the group work, students of each group were asked to present their group works done on the different concepts of energy. Students were motivated to interact and raise their questions during the presentations. Students were also motivated to relate/link their experiences gained outside the classroom situation to their presentations (classroom situation). They were encouraged for sensing the problems, literature survey/consulting teachers or and peer group members, identification of a particular problem, experimentation for seeking solution, data collection, interpretation of data, drawing inferences to any one topic of their choices related with the concepts of energy. Some photographs of the activities conducted during teaching learning process are shown below:

Photograph 1 shows students' participation participation in the group work.

Photograph 2 shows students' in the presentation of group work.

Photograph 3 shows students' participation in the quiz competition.



Photograph 4 shows students' participation in presentation of their concept maps.

Lesson on the topic energy was concluded by interaction with the students and asking them to summarize the lesson through concept maps. Assessment of students' learning during conduct of the activities (group exercise, group work, presentation of concepts through mapping, oral presentation of concepts, experimentation/conducting practicals and expression of thoughts) related to the teaching learning the concepts of energy was done continuously and comprehensively through observation, orally asking open ended/higher level thinking/skills based questions, administering research tool and engaging them in discussion and performing activities (Photographs 1-4). They were also asked to summarize the lesson after its completion in the class using graphical tools. Students were personally interviewed and feedback regarding them was also taken from their teachers. They were encouraged to solve the problems on black board and present their ideas about a particular concept of energy. Their work was regularly examined and corrective measures were taken accordingly. They were also given opportunity to reflect and imbibe on various aspects of the activities performed by them. There was regular practice in the classroom to ask questions in between and after the completion the topic/concept. Students were grouped into small groups. Each member of the group was assigned a topic for seminar, group work presentation, written assignments, projects and practicals. Proper record of each activity was maintained. During the presentation of assignments, students were allowed for cross questioning or to ask any other questions without any hitch and fear to their peers. It resulted in charging up the students to question things in the classroom and to apply their natural curiousity to the world outside the classroom situations (S.V. Sharma, 2014, Sharma S. V. and Yadav S., 2013, SharmaS.V.,2013,geordiescience.blogspot.in/2013/04/energy-in-2015-nationalcurriculum.html).

Analysis of the Responses

- Analysis of the responses of students of controlled and experimental groups in terms of percentage (%) of correct and wrong responses were carried out to each item of the research tool related to the concepts of energy and their percentages of the responses are listed in Table 1 and shown graphically in Figure 2 and 3 respectively. Average percentage of correct responses and wrong responses of students of experimental group was 67.10 and 32.90 respectively where as for students of controlled group respective average percentage was 34.20 and 65.80 for correct responses and wrong responses.
- Only 2.7% students of controlled group responded item No. 20 of the research tool which was related to the preparation of concept map on energy where as 97.3% students of experimental group responded this item correctly. Similar situation prevails in other items in which applications of energy were explored in daily life situations.
- Mean scores, standard deviation (S.D.) and 't' value of students of controlled and experimental groups were calculated and compared with the tabulated values (Table 2) which reveals that there is a significant difference in the conceptual understanding the concepts of energy of two groups of students. Performance of students of experimental group is batter in comparison to students of controlled group where traditional teaching learning approach was employed. This is clearly evident from Table 1 and graphical representation of responses (Fig. 2 and 3) of students of both the groups.
- At significant level 0.05 calculated 't' value (6.41) from the data scores of students is higher than the tabulated 't' value (2.02) (23) which indicates that there exits a significant difference in the understanding the concepts of two groups of students.

Table 1: Analysis of the responses of the students of controlled and experimental groups.

Item No.	Controlled Group		Experimental Group	
	% of Correct Responses	% of Wrong Responses	% of Correct Responses	% of Wrong Responses
1	47.2	52.8	55.2	44.8
2	19.4	80.6	47.3	52.7
3	41.7	58.3	78.9	21.1
4	0	100	60.5	39.5
5	25.0	75.0	78.9	21.1
6	5.6	94.4	78.9	21.1
7	66.7	33.3	73.6	26.4
8	16.7	73.3	57.8	42.2
9	25.0	75	60.5	39.6
10	33.3	66.7	60.5	34.5
11	58.3	41.7	73.6	26.4
12	63.9	36.1	52.6	47.4
13	38.9	61.1	60.5	39.5
14	30.6	69.4	55.2	44.8
15	75	25	73.6	26.4
16	55.6	44.4	73.6	26.4
17	41.7	58.3	60.5	39.5
18	8.3	81.7	60.5	39.5
19	27.8	72.2	84.2	15.8
20	2.7	97.3	94.7	5.3

Table 2: Mean scores, standard deviation (S.D.) and 't' value of the students of controlled and experimental groups.

Group	N	Mean	Median	S.D.	't' *value
Experimental	46	25.5	23	4.67	6.41
Controlled	46	12.5	11.5	7.97	

* Significant at 0.05 level and degree of freedom =38

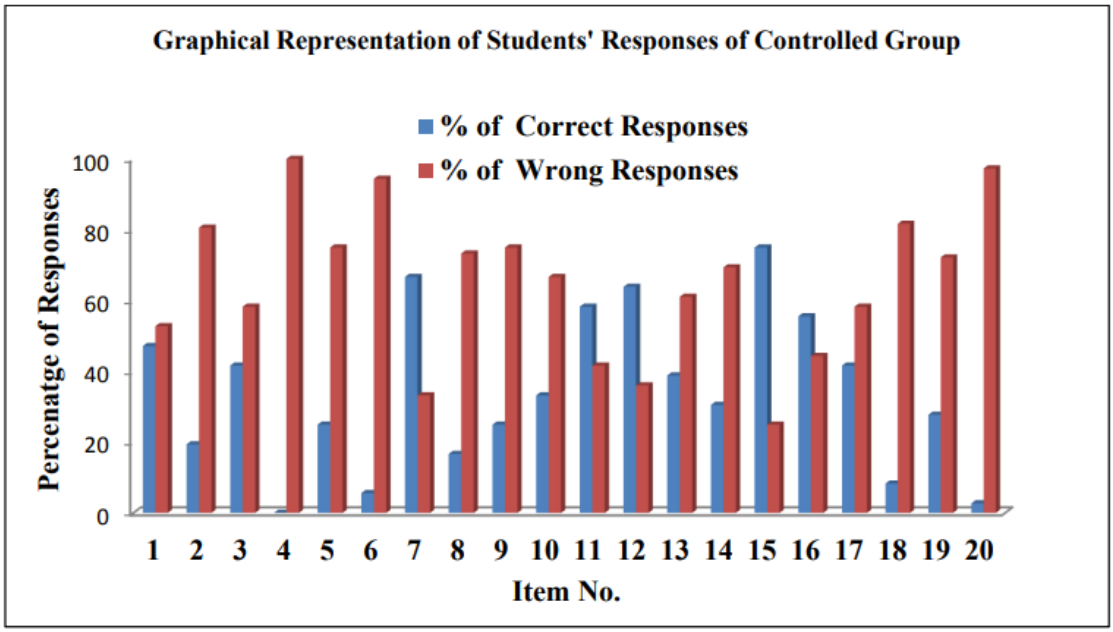


Figure 2: Graphical representation of students' responses of controlled group.

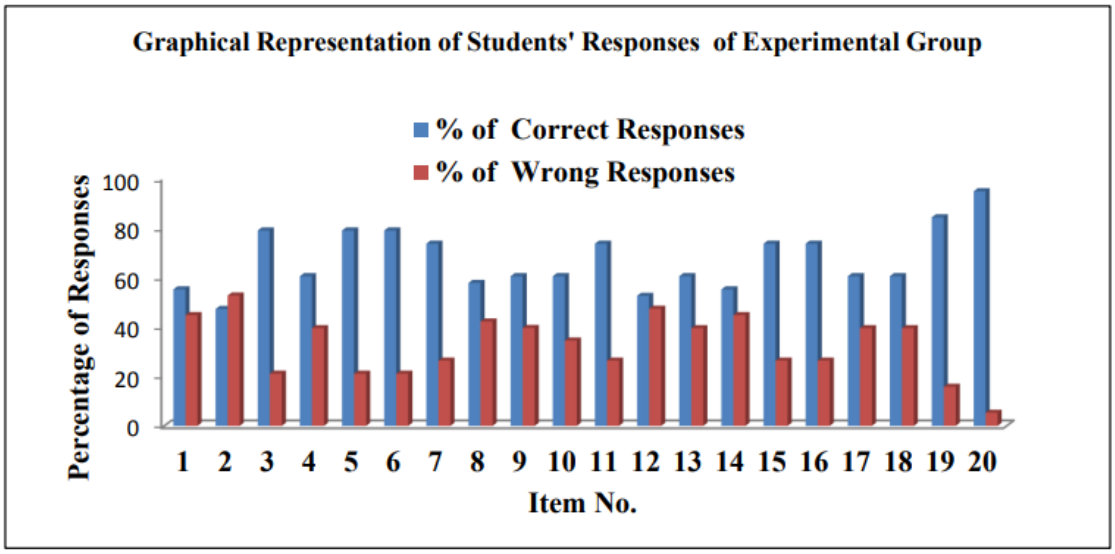


Figure 3: Graphical representation of students' responses of experimental group.

Implications

- During the present study common concern experienced was that the family environment of the students does not encourage them for learning. Lack of motivation of students was also noticed. Students were having fear of their teachers. However, their teachers were very much helpful to promote them toward their learning the concepts of energy. It was observed that students were very hesitant in asking questions during the teaching learning process in the classroom situation. It was also observed that the teaching learning process was unresponsive and passive in the regular classroom situation where traditional approach of teaching learning was employed. It was experienced that there exists rigidity amongst teachers in accepting the educational challenges with regards to today's scenario in relation with curriculum, class room situation, teaching learning materials/resources, use of ICT in teaching learning process, teaching learning approaches and examination reform. It is, therefore, envisaged that efforts are needed to make students friendly constructivist learning environment in the schools. Students should be encouraged to behave like friends and ask questions during teaching learning process. Their involvement and participation in different activities related with the teaching learning process must be ensured through group exercise, group work, quiz, seminar, project work and oral presentation of concepts related to energy. Students should be motivated for participation in presentation of concepts of energy through concept mapping and experimentation/conducting practicals. They should also be motivated to use of graphical tools for their presentations on concepts of energy.
- It was found that students were not fluent in their communications during the interaction. Accordingly, adjustment may be made by the teachers to match with their frequency of communications and learning the concepts of energy.
- Traditional approach (Chalk and talk (lecture)) of teaching learning was found to be the only near and dear approach to the teachers; they like it the best and employ it the most in their class room transaction. It should be realized that mastery of content and approach of delivery of content both are equally important during the teaching learning process at school level. Also keeping in view the better performance of the students of experimental group over the students of controlled group it is suggested that there should be a shift from traditional approach to constructivist approach of learning the concepts of energy.
- Performance of students is found to be independent of their background (rural/urban). Opportunity, motivation, constant efforts, reinforcement and remedial measures may result in enhancing their performance and understanding the concepts of energy notably.

Conclusion

The finding of present study clearly indicated that the students' performance of experimental group was significantly improved in comparison to students' performance of controlled group. In experimental group teaching learning process was carried out using constructivist approach whereas in controlled group it was carried out using traditional approach. Students were found to

sit passively in case of traditional approach where as in constructivism approach students were actively involved, rather than passively absorbing information. Hence, it is suggested that the teachers may replace traditional approach of teaching learning the concepts of physics by the constructivist approach for quality learning. Also they can update their content and pedagogic aspects in context to the emerging trends of the educational challenges of today's scenario.

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