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Problem based learning in biology: Its effect on achievement motivation of students of 9th standard

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Abstract
The study was undertaken to find out the effect of Problem-Based Learning (PBL) in Biology on achievement motivation of students of class ninth studying in government schools of Chandigarh. A sample of 200 students was selected randomly from two schools. Experimental group comprising hundred students received the instruction by Problem Based Learning while the control group comprising hundred students received biology instruction by traditional teaching method. The data was collected via the pre-test and post-test administration of Achievement Motivation Scale. The results were statistically analyzed using SPSS software by employing both descriptive and inferential statistics (t-test). Results indicated that (i) the Problem Based Learning group significantly showed high level of achievement motivation than the students of control group, (ii) Significant and positive co-relation was found between pre and post achievement motivation scores, and (iii) Significant difference was found in the gain achievement motivation scores of students taught through problem based learning. Thus, problem based learning positively impacted achievement motivation level of the students.

Keywords: problem-based learning, lecture method, achievement motivation

1. Introduction
At each level of education, primary, secondary, senior secondary, college and university, a teacher has to face the challenge of how the content be presented to the students so that students are not only able to gain and memorize knowledge, but are also able to become learners who are self-directed and in whom problem-solving skills could be inculcated which in turn will help them to be successful in their careers and also enhance achievement motivation. Past few decades has witnessed a tremendous progress in science and Technology, which drastically has changed the way we communicate, access information, buy daily routine items. But method of teaching and learning process has not changed much. So, there is an urgent need to build up this gap for the generation today in order to make an intellectual who is aware of what, why and how is he learning so that one can easily understand the practical aspects of what is being taught in school, colleges and university. Teaching learning process accompanied with stress and fear leads to temporary learning. A learner should not only be self-motivated and have a desire to be successful but should also be a constructor of one's knowledge for the long retention and better understanding of the concepts. One such method which can fulfill all these objectives is Problem based Learning.

2. What is Problem Based Learning?
Problem based learning is learning based on problems that are realistic, ill structured and are challenging. Savery (2006) considered that Problem-based learning (PBL) empowers learners to conduct research, integrate theory and practice, and apply knowledge and skills to develop a viable solution to a defined problem and is an instructional (and curricular) learner-centred approach. In view of De Graaff, & Kolmos, (2007), "Problem-Based learning an educational strategy is a method which organizes the learning process in a manner in which students actively engages them for finding answers."According to Shamsan and Syed, (2009) [9] PBL is a strategy that promotes life-long learning and is a powerful classroom process that uses real-world problems that motivate students on identifying and applying concepts and information related to research, communicate effectively and work collaboratively. PBL is an effective technique which involves active learning rather than passive for students to learn, retain, integrate, and apply information. Klegeris and Hurren (2011) described problem based learning as a technique where problem drives the learning in a learning environment in small groups, supervised by tutors. Thus, from the definitions given by different educationists and researchers, it is clear that Problem Based Learning is an instructional strategy in education where students' works in small collaborative groups on open ended problems which are realistic and is centered on the student. It empowers learners in integrating theory and practice, in conducting research; developing a viable solution by applying skills and knowledge and where teacher is just a facilitator who facilitates the learner in constructing knowledge.

3. Achievement Motivation
Colman (2001) [3] defined achievement motivation involves a competitive drive to meet standards of excellence. Ohm (2014) illustrated that Achievement motivation is divided into two goal orientations: mastery and performance and are fundamental to how people attend to tasks. The motivation is the force that forms the foundation that helps the individual to attain the objectives.

4. Purpose and Significance of Study
In the digital age which is technology oriented there is a great need to raise the level of achievement motivation of the students. All students differ from one another in the strength of achievement motivation. Teachers, school, class room

environment, home and society play an important role in developing achievement motivation in the students. If learning is associated with real life problems into the classroom situation as in Problem Based Learning, achievement motivation of the students can be enhanced. Although Problem based learning method of teaching is more than 40 years old, its applicability in Indian school curriculum is negligible though few researches in medical sciences and Engineering have been reported. Moreover, education system in India is more exams oriented and less emphasis is laid on the applicability of the subject matter taught. The study of the subject of biology is an important aspect of the child development at school level as it helps in understanding one's own body processes as well as gives a better and a scientific understanding of the living things around them. Biology can be best learned if associated with day to day to life and one's surrounding which contributes towards maximum involvement of the child. Moreover, the research would help in adding a new method of teaching in the field of education at school level which is rarely used in Indian schools. In addition to this, the study has been taken up in the Government school set up where resources are limited; success rate of students is much less than the students who are studying in private, public or convent schools, this method would be an inspiration for those teachers who would like to bring best out of the students. The study was conducted to investigate the effect of Problem Based Learning in biology on Achievement Motivation of students of 9th standard in biology.

5. Literature Review

Tella (2007) [10] investigated the impact of motivation on academic achievement of secondary school students in mathematics and found significant gender differences when impact of motivation on academic achievement was compared and when the extent of motivation was taken as variable of interest on academic achievement in mathematics based on the degree of their motivation results were significant. Ali, Akhter, Shahzad, Sultana, & Ramzan (2011) [1] studied the impact of motivation on students' academic achievement in problem based learning environment by employing pre-test-post-test design in elementary level mathematics. Significant impact of motivation on the academic achievement was found in students in problem based learning environment. Etherington (2011) [5] found that problem based learning had had a positive impact on the motivation of pre-service teachers to teach science ideas within a real world context. Klegeris & Hurren (2011) in their study on learning biochemical and physiological processes through problem based learning monitored the attendance of students and by using formal and informal surveys, demonstrated a a significant positive impact of PBL on student motivation to attend and participate in the course work. Wijnia, Loyens, & Derous (2011) [12] in the study examined the effects of problem-based learning [PBL] versus lecture-based [LB] environments on undergraduates' study motivation. The results indicated higher scores on competence by PBL students but did not differ from LB students on autonomous motivation. In conclusion, PBL does not always seem to lead to higher intrinsic motivation. It is therefore crucial to build in the right amount of structure in learning environments and balance controlling elements versus autonomy, even in learning environments that are intended to be motivating for students. Tella (2007) [10], Ersoy (2010), Ali, Akhter, Shahzad, Sultana, & Ramzan (2011) [1] and Etherington, (2011) [5] and Klegeris & Hurren (2011) indicated significant impact of motivation on the academic achievement of students in problem based learning environment. Wijnia, Loyens, &Derous (2011) [12] have reported that PBL does not always lead to higher intrinsic motivation. From the review of related literature both positive and negative effects of problem based learning was found but the studies pertaining to effect of problem based learning on achievement motivation, are inconclusive, especially in the subject of biology of secondary class, which necessitates further investigation.

6. Hypothesis

The null hypothesis formulated for the study was:
There will be no significant difference in achievement motivation scores of students taught through lecture method and problem based teaching strategy in Biology.

7. Method and Procedure

Detail about research design, sample, tool used, procedure and statistical techniques employed are given below:

7.1 Research Design

The study employed pre-test and post-test experimental research design.

7.2 Population and Sample

A group of students in the age group of 13 to 16 years studying in Class IX, of Government Schools in Chandigarh affiliated to Central Board of Secondary Education (CBSE) with English as medium of instruction constituted the population of the study.
Initially, a sample of 200 students was selected from two Government schools of Chandigarh. Experimental group comprising hundred students received the instruction by Problem Based Learning while the control group comprising hundred students received biology instruction by traditional teaching method. Students were randomly assigned to both the groups. The actual results were computed on 188 students as 12 students formed the experimental mortality due to inadequate data. The PBL group (n=93, Female -39, Male- 54) who received biology instruction by PBL and the control group (n=95, Female 35, Male - 60) who received biology instruction by traditional teaching method i.e. lecture method. The researcher did not disturb the normal set up of the classroom as both the groups constituted students of high, average and low intelligence as found out by the academic records of the students of previous class. The PBL group received biology instruction in PBL format and the control group received biology instruction with traditional teaching method i.e. lecture method. Problem based learning is a method in which students work together in a group of 3-5. So, in the present study the sample of 100 students was divided into 24 groups consisting of 4 students each randomly distributed into groups by lottery system.

7.3 Tool Used

The standardized Achievement motivation scale developed by Deo and Mohan (2011) published by National Psychological Association, Agra was used in the study which consisted of 50 items based on 15 dimensions (Academic Motivation, Need Achievement, Academic Challenge, Achievement Anxiety, Importance of Grades/ marks, Meaningfulness of Task,

Relevance of School/ College to further goal, Attitude towards Education, Working method, Attitude towards teachers, Interpersonal Relations, Individual Concern, General Interests etc. - 13 negative and 37 positive items). A positive item carried the weightage of 4, 3, 2, 1 and 0 respectively for the categories of Always, Frequently, Sometimes, Rarely and Never. A negative item carries the weightage of 0, 1, 2, 3 and 4 for the same categories respectively. The summation of all the positive and negative items gave the total score. It is based on five point Likert scale. For the present study, English version of the scale has been used.

7.4 Procedure

The study was conducted in the beginning of the session in the month of April, 2016 when students after passing class eighth entered class 9 and had negligible knowledge about the syllabus. The duration of the study was 5 weeks in April and May. Achievement motivation of both the groups was evaluated before and after the study. The independent variable was the intervention (the PBL and the traditional instruction). The dependent variable was posttest achievement motivation. To examine the effect of PBL, some key topics on The Fundamental Unit of Life, Tissues, Why do we fall ill, Diversity in living organisms, Improvement in food resources and Natural resources were selected for the study. The study was conducted parallel in both the groups. Each group was given one worksheet (Name of the group Members, Group Leader, What is the problem, What do we know about the problem, What information or resources will be needed to solve the problem, what should be done to solve the problem, solution, student notes for writing extra information or query if any) for each session. Students of PBL group were allowed to use science laboratory, computer laboratory and school library to collect data to solve the problem. The Problem based learning session was conducted in three phases (Wijina, 2014, pp 87) [11] after presenting the problem to the students: (1) initial discussion phase, (2) self-study phase, and (3) a reporting phase. In initial phase collaboratively discussed the problem on the basis of previous knowledge and common sense to arrive at possible solutions and explanation for the problem. As the previous knowledge was insufficient to completely explain the problem, learning issues were formulated (i.e., questions) which further directed self-study. Students prepared themselves for studying; selecting and integrating information from varied learning resources (e.g., science text book, Internet, library, science laboratory) with the aim of finding an answer to the learning issues in the self-study phase. After discussing and noting down the solution of the problem in the worksheet, the problem was discussed in the class in the brainstorming session (Reporting phase). Although group of 4 students each was made in Experimental (PBL) group, but the achievement motivation scale was individually administered as pre-test and post-test to both the groups. Proper track of the attendance of the students was kept by the researcher during the study.

7.5 Statistical Techniques employed for Analysis of Data

Following statistical techniques were employed for analysis of the data collected by SPSS (Statistical Package for the Social Sciences):

1. Descriptive statistical techniques such as mean, median, mode, standard deviation were used to determine the nature of the distribution of scores of variable.
2. Differential analysis by using the t-test to analyze the effect of problem based.

8. Results and Discussion

According to the results of pre-test data for achievement motivation as given in Table 1, the experimental (PBL) group and control group had approximately similar value for mean, median and mode. Fig. 1 represents the histogram for Pre Achievement Motivation Score of Experimental and control group which has a bell shaped curve and indicates that the sample is normally distributed. The mean, median and mode of pre-achievement motivation score of experimental and control group is approximately 120 which clearly indicates that the sample in both the groups have the same level of achievement motivation and is normally distributed. This was further proved by applying t-test as given in Table 3. The p-value for the t-test for pre achievement motivation score of experimental and control group was 0.973 which is more than 0.05, hence non-significant which means students in both the groups had equivalent level of achievement motivation. The mean score of pre achievement motivation scale of experimental group was 121.03, control group was 120.93. The average age of the students of experimental group was 13.74, control was 13.79 and that of total sample was 13.77, so we can assume the average age as 14 years. On the basis of raw scores of average motivation z-score of -1.25 was obtained according to the norms of Achievement Motivation Scale to check the level of achievement motivation of the students which indicated that the students of experimental and control group had below average achievement motivation. Thus indicating that experimental and control groups are equivalent on the basis of achievement motivation before conducting the experimental study.

Table 1: Descriptive statistical analysis of Pre Achievement Motivation Score of Experimental (PBL) and Control Group

	Pre Achievement Motivation Score (Experimental group)	Pre Achievement Motivation Score (Control Group)
N	93	95
Mean	121.03	120.93
Median	119.00	119.00
Mode	120	120
Standard Deviation	22.053	21.506

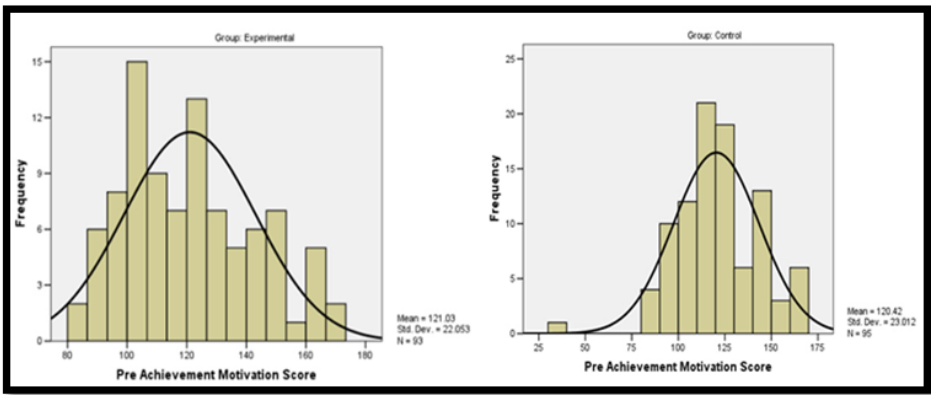

Fig 1: Histogram for Pre Achievement Motivation Score of Experimental and Control Group

The descriptive statistical analysis of post-test achievement motivation scores of experimental (PBL) group and control group (lecture method) is given in Table 2. The mean score of post achievement motivation scale of experimental group was 139.65 and control group was 124.85. The z-score of experimental group was -0.45 and control group was -1.07. On the basis of raw score and z-score we can say that there was an increase in the level of Achievement Motivation in students of both experimental (PBL) and control group but students of PBL group showed higher level of Achievement Motivation than the control group. After the experimental study Achievement Motivation of students of PBL group was raised from below average motivation to average motivation, although there were some students of high motivation also.

Table 2: Descriptive statistical analysis of Post Achievement Motivation Score of Experimental (PBL) and Control Group

	Post Achievement Motivation Score (Experimental group)	**Post Achievement Motivation Score (Control Group)**
N	93	95
Mean	139.65	124.85
Median	138.00	123.00
Mode	129	120
Standard Deviation	22.829	20.82

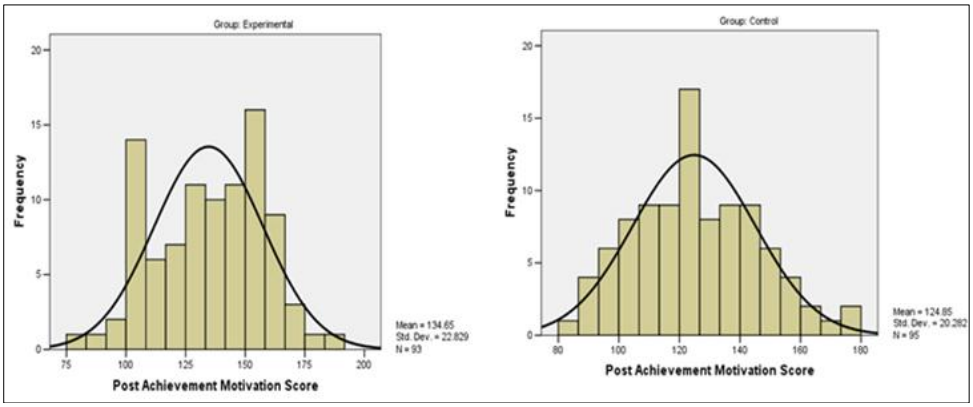

Fig 2: Histogram for Post Achievement Motivation Score of Experimental and Control Group

Students of control group also showed raised level of achievement motivation but not as significant as PBL group as can be seen in Table 3 which revealed that there is a significant difference on behalf of experimental group in their achievement motivation while learning the subject of biology of class 9 through problem based learning.

Table: 3 Table representing t-test for Pre and Post-test Achievement Motivation Score of Experimental and Control Group

Independent Samples Test							
	t-test for Equality of Means						
	t	**df**	**Sig. (2-tailed)**	**Mean Difference**	**Std. Error Difference**	**95% Confidence Interval of the Difference**	
						Lower	**Upper**
Pre Achievement Motivation Score	.033	186	.973	.106	3.177	-6.161	6.373
Post Achievement Motivation Score	3.111	186	.002**	9.793	3.148	3.582	16.003

Paired sample co-relation was found to check the co-relation between pre-test and post-test achievement motivation scores. Both the groups experimental (PBL) and control group had a positive and significant co-relation as shown in Table 4.

Table 4: Paired Samples Correlations of pre and post test

Group		N	Correlation	Sig.
Experimental	Pre Achievement Motivation Score & Post Achievement Motivation Score	93	.406	.000
Control	Pre Achievement Motivation Score & Post Achievement Motivation Score	95	.503	.000

On comparing the mean of gain achievement motivation scores of experimental and control group as given in Table 6, and applying Levene's Test for Equality of Variances f-value of 0.249 was obtained indicating equal variance. T -test value of 2.924 on comparing gain achievement motivation score had a significance value of 0.004 which is less than 0.05 which shows that gain achievement motivation scores of experimental group are better than that of control group as shown in Table 5 and Table 6.

Table 5: Means of Gain achievement motivation score of experimental group and control group.

Group Statistics					
	Group	N	Mean	Std. Deviation	Std. Error Mean
Gain Achievement Motivation Score	Experimental	93	14.6129	24.46027	2.53641
	Control	95	3.9263	20.85270	2.13944

Table 6: Comparison of Means of Gain achievement motivation score of experimental group and control group.

Independent Samples Test									
	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Gain Achievement Motivation Score	1.335	.249	2.924	186	.004	11.68659	3.31261	3.15147	16.22171

9. Conclusion

In the light of the results and analysis, it can be concluded that problem based learning (PBL) has a positive and significant effect on achievement motivation scores and gain achievement motivation scores of the students of class ninth while learning the subject of biology. High level of achievement motivation in students of PBL group can be linked to working in small groups which involved self-learning and motivated students at every step to explore more. Although there is no research which has intimated the effect of problem based learning on achievement motivationin biology of secondary class but various researches have reported that PBL instruction can increase and positively influence student's motivation (Tella, 2007; Ersoy, 2010; Ali, Akhter, Shahzad, Sultana, & Ramzan, 2011; Etherington, 2011and Klegeris & Hurren2011) [10, 1, 5].

10. Implications

The study was limited to students of class ninth studying in government schools of Chandigarh and in the subject of biology only. Problem based learning has a wider scope which can be utilized in other subjects taught in school curriculum which will not only enhance the achievement motivation of the students but also help in better understanding of the subject being taught by linking it to day to day life. The knowledge and understanding of problem based learning will definitely help teachers in enhancing achievement motivation of the students. The study of achievement motivation is more important than study of intelligence and talent; because the intelligence generally is a constant issue but we can improve and change the achievement motivation by using the suitable learning approaches and strategy (Besser, 1995). In the digital age which is technology oriented there is a great need to raise the level of achievement motivation of the students. All students differ from one another in the strength of achievement motivation. Teachers, school, class room environment, home and society play an important role in developing achievement motivation in the students. If learning is associated with real life problems into the classroom situation, achievement motivation of the students can be enhanced.

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