J. Appl. Environ. Biol. Sci., 7(1)170-179, 2017
© 2017, TextRoad Publication
ISSN: 2090-4274
Journal of Applied Environmental and Biological Sciences
www.textroad.com

Improving Students' Attitude towards Biology as a School Subject: Do the Instructional Models Really Work?

M. Naqeebul Khalil Shaheen, M. M. Kayani

Department of Education, International Islamic University Islamabad

Received: September 3, 2016
Accepted: November 27, 2016

ABSTRACT

The study aimed to compare the effectiveness of instructions based on 7E Instructional Model and Traditional Instructional Model in assessing students' attitudes toward biology. The study sample [122 students = 62 boys and 60 girls] was randomly selected using pre-test post-test control group design. Students included in the control group[61 students = 31 boys and 30 girls] received instructions based on Traditional Instructional Model, on the other hand, experimental group [61 students = 31 boys and 30 girls]received instructions based on the 7E[Elicit, Engage, Explore, Explain, Elaborate, Evaluate, and Extend] Instructional Model. An independent sample t-test was used to check the equality of groups in the pre-tests scores of Biology Attitude Questionnaire (BAQ) and Integrated Science Process Skill Test(ISPST). As there was a significant difference in the scores of Integrated Science Process Skill Test (ISPST), hence it was decided to use it as a covariate. ANCOVA and*t*-test were also used for the data obtained through posttests. It was found that in posttest scores students' Biology Attitude Questionnaire (BAQ) the experimental group showed significantly better results. However, there was no interaction effect of treatments and gender in terms of students' Biology Attitude Questionnaire (BAQ). It was recommended to implement instructions based on the 7E Instructional Model in different fields of study in general and biology in particular.
KEYWORDS: The 7E Instructional Model; Attitude towards Biology; Students' Integrated Science Process Skills; Experimental Study; Science Education

1. INTRODUCTION

Today the world has become a global village. Distance between people and places ends just on a single click on computer. But, like every picture, this globalized world has two sides. Brighter one reflects the ease and comforts man enjoying today, and darker one points the challenges, he has to face, in order to make successful survival on this planet. It is contemporary generation which is supposed to face these challenges. And no other weapon but education, alone, prepares the generations to combat these challenges [13]. An up-to-date and innovative mode of education is what really needed in a society to nourish and garnish [4]. It utilizes both the mental and physical capacities for the betterment of present and future. Therefore, it demands certain reforms with the passage of time. These reforms aim at student centered learning approach [51]. Another requires spreading quality education according to the demands of contemporary society and needs of the learners [63]. In consequence, a balanced, moderate and reflective system of education is at disposal.

Education, in itself is a broader term which includes many fields, such as history, science, literature, religion et cetera. Among these, science, "study of facts and figures based on experiments" holds a special status [51]. In many ways, it (science) can safely be said, "the savior of mankind" [32]. No field of life is left aside of its impacts. From investigations to discoveries, it has shortened the journey of man. Verily, it brings into light what is hidden from man's sight [4]. Keeping in view its celebrated position around the globe, transformation of scientific knowledge has had a big challenge for the teachers. Very demanding! It needs versatile approaches, methods and strategies for each level of learners [50].

Secondaryeducation inPakistan has a bleak picture[51]. There is a huge gap between the international standards of secondary education and the mode of education running at national level[40]. In fact, there is a dire need of improvement in all the fields of education in general and science education, in particular [51].As secondary level education attempts to touch all the three domains of mind i.e. cognitive, psychomotor, and affective so the learners are required to be motivated in practical application of what they acquire[66]. In this connection, students' social behavior can be improved by learning science[41]. This habit formation or attitude development is the key responsibility of the teacher. Verily s/he becomes a key figure inside the classroom who controls and directs all the

[a]**Corresponding Author:** Muhammad Naqeebul Khalil Shaheen, Ph.D Scholar at International Islamic University Islamabad. Email: *naqeeb.shaheen@gmail.com, +92-3325890577*

activities like an expert orchestra leader [2]. At educational institutes, they play their vital role by encouraging positive responses and promoting meaningful provision of conceptual, factual, procedural and meta-cognitive knowledge about the world in which they live [4]. This is what education system lacks [37, 61]. Those who are responsible to transfer the knowledge and skills are themselves either not equipped or inefficient [51]. In Pakistan, the programs devised for secondary teacher education, consist of a number of methods and techniques. However, in certain cases the productivity of these initiatives comes under questions when trainees could not decide when, why and how to use them. The consequence is obvious: successful classroom communication remains alien. Similarly, the teachers are seen lingering while setting lesson objectives; planning activities; and engaging learners. Therefore, teachers need to deem carefully whatever they desire to present in front of their learners [48].

This loophole motivates the researchers to look forward for a constructive framework which is able to contest contemporary challenges[50]. It does not encourage the traditional approaches because in traditional teaching approaches, a single entity-teacher takes all the decisions in the classroom [32]. Consequently, a constructivist motivates the students in such a way that they think critically about the situation [63]. The role of the teacher is of a facilitator or guide who suggests only the possible ways or situations to learning [32, 46, 49, 60].

Scientific attitude and attitude towards science are clearly differentiated by Bennett. According to him the term scientific attitude encompasses the skills and is linked to take the charge of practical work[9]. Moreover, it is related to the scientific method or styles of thinking of a person. On the other hand, attitude towards science are the notions and images created in the minds of learners by interacting directly with multiple situations. Furthermore, Yara defined attitude towards science as feeling or interest of learners towards the study of science[67]. Hence, it totally depends upon the interest of the students towards science. Learning science to analyze the related effects on students' attitude toward achievement and understanding, Simpson et al. as well as Petty and Cacioppo stated that attitude in literature is defined as a general tendency which can be a positive or negative sentiments about an object, person, place, ideals, or problem[44, 56, 57]. In literature, the said term has been defined in a number of ways but all these definitions have taken it as a positive or negative tendency to feel, act or think about something [26, 45].Webster and Fisher conducted a study which strengthened the notion that students' achievements in the field of science were linked with their attitudes towards science[64]. In the same way, Cavallo and Laubach considered course enrolment as a factor working behind the student's attitude toward science[16].

Many research studies conducted by the researchers not only found the effectiveness of the instructional models with respect to students' achievements in science but a lot of them also identified covariate(s) that may affect the results of the studies.Among these studies, some researchers have focused on cognitive variables like rationale ability and approach to learning that may play their roles in the process of investigation, on the other hand, a few other variables of affective domain like attitude and motivation on achievement of science may also influence the results of the study [11, 17, 18, 19, 20, 25, 36, 38, 52, 54]. Moreover, it is vital to mention a number of other factors that may affect the attitudes and motivation level of the students towards the process of learning. Thereupon, the analysis of literature cited above draws a conclusion that there is a need to explore the attitude of students towards studying specific subject (s). Hence, the effect of Instructional Models on students' attitude towards science is considered much vital for the process of learning.

Improvement of science achievement by using more result oriented instructional strategies; promotion of the roles of students and teachers as active participant and facilitator respectively are some of the vital areas of interest to the science educators [43]. Hence, an important question in science education is which type of teaching strategy may not only promote meaningful learning in the students but also improves their attitudes towards science. In this regard, an approach known as the 'conceptual change approach' is used today [13]. It is based on the philosophy that the learners use their ecology of concepts whenever they face situations which they do not encountered in past. It allows them to decide whether the new information is based on any logic, is reliable and has the power to predict explanation of the certain phenomena [33]. The phenomenon of conceptual change is addressed in the instructional models based on constructivism [59]. Since their evolution in 1960s, the instructional models attracted many researchers and thousands of researches to measure the effectiveness of instructional models [39].

The realization of the ground realities tended to unfold the effectiveness of instructional models for the Pakistani learners. Therefore, the very study is based on one of the instructional models named as "the 7E Instructional Model". It aims at the participation of learners and helps in reshaping classroom into learning communities where the learners are free to learn whatever the way they want. Besides, they are also given an insight to judge their progress by themselves. The whole exercise is carried out to prepare students for independent learning [27].

1.1. Objectives of the Study

This study was aimed and designed;

1. To compare the effectiveness of instructions, based on 7E Instructional Model and Traditional Instructional Model on students' attitude towards biology as a school subject;
2. To investigate the effect of gender on students' attitudes toward biology as a school subject.

1.3. Hypotheses of the Study

The hypotheses of the study were:

$H_0$1: There is no significant difference in the mean scores of students' attitude towards biology as a school subject, based on 7E Instructional Model and Traditional Instructional Model when integrated science process skills are to be controlled as a covariate;

$H_0$2: There is no significant difference in the mean scores boys and girls with respect to students' attitudes toward biology as a school subject.

$H_0$3: There is no significant effect of interaction between gender difference and treatments on students' attitude towards biology as a school subject when integrated science process skills are to be controlled as a covariate.

2 MATERIALS AND METHODS

Instructional Models use various activities designed in such a way that improve students' attitude towards learning new things. Such different activities used in the current study are discussed below.

2.1. Methods and Activities of Traditional Instructional Model

The teaching and learning activities in the Traditional Instructional Model used programmed lectures, in addition, well prepared notes and ninth grade biology textbook were also used to explain the concepts. Moreover, computer and projector were also used as helping aid for showing power point slides and pictures. The teachers also used related charts, flash cards and blackboard as visual aids during lectures. Here, the major focus was on teachers' active role and students' passive role. The teachers used to explain the concepts in front of the students and the students closely observed, took notes of the illustrations and the facts told by their teacher. The role of the students was of passive listeners and their consequent conceptions were not addressed. However, students were asked to discuss their problems and difficulties with the teachers[13].

2.2. Methods and Activities of the 7E Instructional Model

The activities used in the 7E Instructional Model were programmed in such a way that guaranteed maximum and dynamic participation of the students in the process of learning. These were mainly based on laboratory investigations. Moreover, computer simulations and projector were also used as helping aid for showing power point slides and pictures. The teachers also used related charts, flash cards and blackboard as visual aids during activities at times[14]. All the phases of the 7E Instructional Model were kept in mind when the activities were going on. Promoting students' conceptual understanding of "life and biodiversity" concepts were the main aims of the activities used here.

In elicit phase, the first in the instructional model, when learners found new information, the knowledge gained in the past served as foundation on which the new building was constructed. Here, the students came across a number of questions related to their alternative conceptions posed by the teacher. Therefore, they remained successful in attempting to activate students' previous knowledge about the current situation.

The engagement phase included such the activities which helped the teachers to get the students attentive and prepare to absorb new information. Therefore, the students learnt how to link the new situation to the previous knowledge. Consequently, the organization of students' thinking processes led to develop better understating of the concepts.

The activities involved in the exploration phase focused to generate the ways by which the students might perceive scientific phenomena occurring around them. This included identification of the systematic procedures, recording information, developing hypotheses, designing and planning suitable investigations, isolating variables, interpreting outcomes, constructing graphs and arranging the conclusions.

The students became able to determine their level of conceptual understanding about the topic(s) with the help of the activities used in the explanation phase. Teachers helped their students to generalize the concepts coherently and consistently. They also guided the students in introducing unique scientific terminologies and queries. All these efforts motivated them to describe the outcomes of their investigations by using the newly scientific terminologies.

In the elaboration phase, the activities were arranged so that the students got a chance to use the prior information to the new situation. It included posing innovative questions and formulation of hypotheses to be tested.

The activities involved in the evaluation phase gave students a chance to evaluate the developed what they have gained. The teachers used different activities like role playing and mind-maps etc. to evaluate the learning outcomes.

At extend phase the students were supposed to learn the concepts, therefore, the activities in this phase were arranged so that the transference of learning was focused [27].

2.3. Methods and Procedures of the study

All the students studying Biology at secondary level were considered as the target population of the study. However, to reach the target population was not an easy job. Therefore, an accessible population was taken which composed of the students of same grade and group from the District Rawalpindi. Random sampling technique was used to categorize both the groups [control and experimental]. Hence, the study used Pre-test post-test control group design[21, 30]. Total number of participants in the study was one hundred and twenty two [sixty girls and sixty two boys]. Experimental group [thirty girls and thirty one boys] received instructions based on the 7E Instructional Model, whereas control group [thirty girls and thirty one boys] received instructions based on the Traditional Instructional Model.

The researchers used two standardized research instruments for this study after taking permission of the authors.

1. Biology Attitude Questionnaire (BAQ) developed by Prokop et al. in 2007[47]
2. Integrated Science Process Skills Test (ISPST) developed by Monica in 2005

3 RESULTS

This section presents analysis of data and interpretations based on it.

3.1. Descriptive Statistics

This section presents an overview of the data analysis.

Table 1
Descriptive Statistics

Test	Group	N	Min	Max	M	SD	Skewness	Kurtosis
Pre-BAQ	Control	61	30	56	39.11	6.875	0.993	0.352
	Experimental	61	30	56	41.52	6.835	0.331	-1.004
Post-BAQ	Control	61	40	60	48.38	6.814	0.219	-1.172
	Experimental	61	41	64	52.00	6.919	0.049	-1.252
ISPST	Control	61	10	25	16.07	3.820	0.306	-0.873
	Experimental	61	13	25	18.33	3.198	0.248	-0.764

It was witnessed thatStudents' pre-test scores in Biology Attitude Questionnaire (Pre-BAQ), control groups ranged from 30 to 56 with evident mean of 39.11;while, experimental groups' scores ranged from 30 to 56 with evident mean of 41.52 [Table 1]. Moreover, it was found that with respect to the mean scores of experimental and control groups, there was a difference of "2.41" in favor of experimental groups. Students' post-tests scores of Biology Attitude Questionnaire (Post-BAQ) were also analyzed using descriptive statistics. It was witnessed that in control group the said scores ranged from 40 to 60 with evident mean of 48.38. Moreover, in case of experimental groupthe scores ranged from 41 to 64 with evident mean of 52.00. According to the Table 1 a "9.27" increase in students' mean scores with respect to Post-BAQ and Pre-BAQ tests in the control group was found. An increase of "10.48" in the mean scores of students [experimental group] was witnessed. It led to an impression that mean score increase of students' post-test scores of Biology Attitude Questionnaire (Post-BAQ) in experimental group was higher than in control group. Hence, the descriptive analysis of Biology Attitude Questionnaire (BAQ) resulted in favour of the students treated with the 7E Instructional Model as compared to those who were treated with the Traditional Instructional Model [Finding 1].

Students' scores of integrated science process skills test (ISPST) were also analyzed. It was witnessed that in control groups the said scores ranged from 10 to 25 with evident mean of 16.07. Moreover, Students' scores [experimental group] of integrated science process skills test (ISPST) ranged from 13 to 25 with evident mean of

18.33. According to the Table 1 students in the experimental group [M=18.33, SD=3.198]had more integrated science as compared to the students of the control groups [M=16.07, SD=3.820][Finding 2].

Moreover, Table 1 also determined the values of Skewness and Kurtosis. Because the values of Skewness and Kurtosis ranged between +2 and -2, it proved that the data was distributed normally [29].

3.2. Inferential Statistics

Analysis of covariance (ANCOVA) and independent sample t-test were used at a significance level of "0.05" to test the null hypotheses.

3.2.1. Pre-test Scores for testing pre-existing differences

Prior to test the null hypotheses, independent samples t-tests were administered. The purpose of this very exercise was to test whether there existed differences in experimental and control groups with respect to ISPST and Pre-BAQ scores before the treatment period started.

Table 2
Independent samplet-test:Pretest scores of BAQ and ISPST

Test	*t*	*df*	*p*
Pre-BAQ	-1.941	120	.055
ISPST	-3.547	120	0.001

Independent sample t-tests were used to analyze the pre-test scores of Biology Attitude Questionnaire (Pre-BAQ) and Integrated Science Process Skills Test (ISPST)[Table 2]. The results of Pre-BAQ scores indicated that there was no significant mean difference in control group [M=39.11, SD=6.875] and experimental group [M=41.52, SD=6.835] as t (120) = -1.941, p= 0.055<0.050. Hence, it indicated that both the groups [treated with the 7E Instructional Model and the Traditional Instructional Model] had no pre-existed differences in terms of their attitudes towards Biology as a school subject. On the other significant mean difference with respect to students' Integrated Science Process Skills Test (ISPST) scores of the control group [M=16.07, SD=3.820] and experimental group [M=18.33, SD=3.198], as t (120) = -3.547, p = 0.001>0.05 was witnessed. Hence, it indicated that the students treated with the 7E Instructional Model [M=18.33, SD=3.198]had more pre-existed skills to solve the scientific problems as compared to those who were treated with the Traditional Instructional Model[M=16.07, SD=3.820]. To control differences existing already in the statistical analysis, students' integrated science process skills test (ISPST) was decided to be used as a covariate[Finding 3].

3.2.2. Post-tests for testing the Null Hypotheses

In this section the testing of null hypotheses is presented. For this purpose, t-test and ANCOVA were used at "0.05" signficant level.

According to the first null hypothesis, there is no significant difference in the mean scores of students' attitude towards biology as a school subject, based on 7E Instructional Model and Traditional Instructional Model while students' integrated science process skills are to be controlled as a covariate. ANCOVA was used to test this very hypothesis. Before the analysis procedure started, major assumptions made under ANCOVA were tested and met. The brief summary of ANCOVA is given in Table 3.

Table 3
Post-BAQ Scores of Control and Experimental Groups

Source	*df*	*F*	*p*
Groups	1	4.125	0.044
ISPST	1	9.678	0.002
Error	119		

According to the results F (1, 119) = 4.125, p= 0.044<0.05significant mean difference was witnessed [Table 3]. This implied that the students treated with the 7E Instructional Model [N=61, M=52.00, SD=6.919]showed better attitude towards Biology as a school subject as compared to those who were treated with the Traditional Instructional Model[N=61, M=48.38, SD=6.253][Finding 4].

The second null hypothesis stated that there is no significant difference in the mean scores of boys and girls with respect to students' attitudes toward biology as a school subject. Therefore, t-test was carried out.

Table 4
Post-BAQ scores of boys and girls

	Equality of Variances by Levene's Test		Equality of Means by t-test		
	F	Sig.	*t*	*df*	*p*
Equality of variances assumed	1.219	0.272	-1.244	120	0.216
Equality of variances not assumed			-1.241	117.493	0.217

The results$t(120) = -1.244$, $p = 0.216 > 0.05$ showed non-significant effects. The girls [N=60, M=50.97, SD=7.180] showed a slight rise in score but it was not significantly above than the boys [N=62, M=49.44, SD=6.409][Finding 5].

The third null hypothesis stated that there is no significant effect of interaction between gender difference and treatment on students' attitude towards biology as a school subject while Integrated Science Process Skills are to be controlled as a covariate. ANCOVA was used to testthis hypothesis.

Table 5
Students' attitude towards biology: Gender difference and treatments

Source	*df*	*F*	*p*
Group	1	4.234	0.042
Gender	1	3.101	0.081
ISPST	1	9.872	0.002
Group*Gender	1	1.884	0.172
Error	117		

The results $F(1, 117) = 1.884$, $p=0.172>0.05$ reflected non-significant results; hence, the third null hypothesis was rejected [Table 5][Finding 6].

4. DISCUSSIONS AND CONCLUSIONS

The major aim of the study was to investigate the effectiveness of the 7E Instructional Model on students' attitude towards biology. During initial stage of the research, students' attitude regarding biology was sought using Pre-BAQ for understanding meaningful change existing in the participant groups of the study in the perspective of students' attitude towards biology[Finding 1]. Later on, significant difference was witnessed in the students when Post-BAQ responses of the ones who received instructions based on the 7E Instructional Model and those who received instructions based on the Traditional Instructional Model, were examined[Finding 2]. The 7E Instructional Model was found better than the Traditional Instructional Model[Finding 1, 2 & 4]. In 2001, Cavallo andLaubach claimed that there might occur a relation between behavioral tendency regarding science and students' selection of science as a subject of choice. Leaving aside some of the researches, it is evident that learning science remained the topic of interest in a number of researches[34, 42]. The current research reflected when post-BAQ scores of the students were analyzed that a significant difference existed in the mean scores of the students treated with the 7E Instructional Model as compare to mean scores of the students treated with the Traditional Instructional Model, when seen in the perspective of students' attitude toward biology, a course taught at school. When works done in the past were reviewed, it was found that some of the researches strengthened the notion that inclusion of instructional model produced meaningful change regarding motivation so learners get ready for thinking in creative and critical manner, providing greater comprehension of science, inducing positivity about science, increasing skills of process in science, last but not least grooming modern logical expertise [6, 36, 39, 68]. Likewise, the students of experimental group showed more positive behavioral tendency when given chances to work in laboratory, and established better results when examined about laboratory explorations, and remained consistent during the treatment period [14, 15]. One more instance was witnessed which established the fact of enjoyment on the part of the experimental group rather control group [39]. From this, the researchers concluded that the 7E Instructional Model proved useful for developing better attitudes of the students towards biology as a school subject as compared to the Traditional Instructional Model[*Conclusion 1*].

Another investigation which was part of the study was the effect of gender on students' attitude toward biology, a course taught at school. The outcome of the study pointed out absence of any meaningful change on basis

of gender differentiation regarding students' behavioral tendency regarding biology, a course taught at school. Contrary to this, recent researches revealed the female students left the male students behind when seen in the perspective of attitude toward science [1, 3, 23, 31], whereas, some of the studies revealed opposite results by stating that male students exhibited higher tendency as compare to the female students [22, 28, 56, 65]. While the behavioral tendencies are likely to fall down as the learners approach high school and the said tendency is seen on greater level in girls [7]. In another study, no meaningful change was seen on the basis of gender differentiation regarding behavioral tendency of science and success in scientific concepts when coeducation institutes were selected to carry the research[23]. Studies revealed that gender is devoid of producing any impact on students' attitude toward science [5, 8, 10, 13, 24, 35, 55, 58, 62]. The previous studies revealed variations in the results in terms of gender difference with respect to attitudes towards Biology as a school subject which might be due to topographic differences. Hence, the researchers concluded that there was no statistical difference with respect to gender differences when students' attitudes towards biology as a school subject was investigated as a number of studies strengthened this notion [*Conclusion 2*].

5. RECOMMENDATIONS

Students may feel problems in understanding the concepts of biology. One of the reasons behind this attitude is based on the fact that many topics are there in high school biology curriculum. These topics are primary in nature and closely related with one another. The instructions based on the 7E Instructional Model make the learners able to create links in whatever they have learnt and to transfer this knowledge; hence, it eventually creates positive attitudes towards biology. Moreover, this helps them to keep the students away from building wrong conceptions.

Along-with scientific processes, attitude towards science may also affect students' learning. Consequently, while planning the instructional strategies teachers may also consider the 7E Instructional Model.

REFERENCES

[1] Akpinar, E., Yildiz. E., Tatar, N., &Ergen, O., 2009. Students' attitudes toward science and technology: An investigation of gender, grade level, and academic achievement. *Procedia Social and Behavioral Sciences*, 1: 2804-2808.

[2] Albanese, M. A., 2004. Treading tactfully on tutor turf: Does PBL tutor content expertise make a difference? *Medical Education*, 38(9): 918–920.

[3] Anwer, M., Iqbal, H. M., & Harrison, C., 2012. Students' Attitude towards Science: A Case of Pakistan. *Pakistan Journal of Social and Clinical Psychology,* 10 (1): 3-9. *http://www.gcu.edu.pk/fulltextjour/pjscs/2012/1.pdf*

[4] Arends, R. I., 2004.*Learning to Teach* (6th Ed.). McGraw Hill,New York.

[5] Azizoğlu, N., 2004.*Conceptual Change Oriented Instruction and Students' misconceptions in gases*.Unpublished doctoral dissertation, Middle East Technical University,Ankara.

[6] Balcı, S., Çakıroğlu, J. &Tekkaya, C., 2006. Engagement, Exploration,Explanation, Extension, and Evaluation (5E) Learning Cycle and Conceptual Change Text as Learning Tools.*Biochemistry and Molecular Biology Education,* 34(3): 199-203. *http://www.ncbi.nlm.nih.gov/pubmed/21638670*

[7] Barmby, P., Kind, P. M., & Jones, K., 2008. Examining changing attitude in secondary school science.*International Journal of Science Education*, 30(8): 1075-1093. *http://dro.dur.ac.uk/4880/1/4880.pdf?DDD29+ded4ss*

[8] Barrington, B., & Hendricks, B., 1988. Attitudes toward science and science knowledge of intellectually gifted and average students in third, seventh, and eleventh grades.*Journal of Research in Science Teaching, 25*(8): 679-687. *http://onlinelibrary.wiley.com/doi/10.1002/tea.3660250806/abstract*

[9] Bennett, J., 2003.*Teaching and learning science*.Continuum,New York.

[10] Boone, W. J., 1997. Science attitudes of selected middle school students in China: A preliminary investigation of similarities and differences as a function of gender. *School Science and Mathematics*, 97(2): 96-103.*http://onlinelibrary.wiley.com/doi/10.1111/j.1949-8594.1997.tb17349.x/abstract*

[11] BouJaoude, S. B., 1992. The relationship between students' learning strategies and the change in their misunderstandings during a high school chemistry course.*Journal of Research in Science Teaching*, 29: 687-699.

[12] Brown, P. L. & Sandra, K. A., 2007. Examining the Learning Cycle.*Science and Children,* 58-59. *http://www.mcser.org/journal/index.php/mjss/article/download/7311/7000*

[13] Bülbül, Y., 2010.*Effects of 7E Learning Cycle Model Accompanied with Computer Animations on Understanding of Diffusion and Osmosis Concepts*. Doctoral dissertation, Middle East Technical University, Turkey.*https://etd.lib.metu.edu.tr/upload/12612299/index.pdf*

[14] Campbell, Reece, & Taylor,2007.*Biology Concepts and Connection*.Pearson. *https://www.pearsonhighered.com/program/Reece-Campbell-Biology-Concepts-Connections-Plus-Mastering-Biology-with-e-Text-Access-Card-Package-8th-Edition/PGM214195.html*

[15] Campbell, T. C., 1977.*An evaluation of learning cycle intervention strategy for enhancing the use of formal operational taught by beginning college physics students*. Unpublished doctoral dissertation, University of Nebraska, USA.

[16] Cavallo, A. M. L. &Laubach, T. A., 2001. Students' Science Perceptions and Enrollment Decisions in Differing Learning Cycle Classrooms.*Journal ofResearch in Science Teaching*, 38(9): 1029-1062. *http://onlinelibrary.wiley.com/doi/10.1002/tea.1046/abstract?userIsAuthenticated=false&deniedAccessCustomisedMessage=*

[17] Cavallo, A. M. L., 1996. Meaningful learning, reasoning ability, and students' understanding and problem solving of topics in genetics. *Journal of Research in Science Teaching*, 33: 625-656.

[18] Cavallo, A. M. L., Rozman, M., & Potter, W. H., 2004. Gender differences in learning constructs, shifts in learning constructs, and their relationship to course achievement in a structured inquiry, yearlong college physics course for life science majors.*School Science and Mathematics*, 104: 288-300.

[19] Cavallo, A. M. L., Rozman, M., Blickenstaff, J., & Walker, N., 2003. Learning reasoning, motivation and epistemological beliefs: Differing approaches in college science courses. *Journal of College Science Teaching*, 33: 18-23.

[20] Ceylan, E. &Geban, Ö.,2009.*Effects of 5E Learning Cycle Model on understanding of state matter and solubility concepts.*University Journal of Education, Hacettepe.

[21] Creswell, J. W., 2009.*Research Design*. Sage Publications, Inc.

[22] Denessen, E., Vos, N., Hasselman, F., and Louws, M., 2015. The Relationship between Primary School Teacher and Student Attitudes towards Science and Technology.*Education Research International.http://dx.doi.org/10.1155/2015/534690*

[23] Dhindsa, H. S., & Chung, G., 2003. Attitude and achievement of Bruneian science students.*International Journal of Science Education*, *25*(8): 907-922.

[24] Dimitrov, D. M., 1999. Gender differences in science achievement: Differential effect of ability, response format, and strands of learning outcomes. *School Science and Mathematics*, 99: 445-450.

[25] Doğru, A. P. &Tekkaya, C., 2008. Promoting Students' Learning in Genetics with the Learning Cycle.*Journal of Experimental Education*.

[26] Eagly, A. H., &Chaiken, S., 1993.*The Psychology of Attitudes*.Harcourt Brace Jovanovich, Fort Worth, TX.

[27] Eisenkraft, A., 2003. Expanding the 5E Model.*The Science Teacher*, 70(6): 56-59. *http://www.nsta.org/publications/news/story.aspx?id=48547*

[28] Francis, L. J., & Greer, J. E., 1999. Attitude towards science among secondary school pupils in Northern Ireland: Relationship with sex, age, and religion. *Research in Science and Technological Education*, 17 (1): 67-74.*https://www.learntechlib.org/p/165174*

[29] Garson, G. D., 2012.*Testing Statistical Assumptions*.Statistical Publishing Associates, USA.*http://www.statisticalassociates.com/assumptions.pdf*

[30] Gay, L. R., 2009.*Educational Research competencies for Analysis and Application*.National Book Foundation,Islamabad.

[31] Greenfield, T. A., 1996. Gender, ethnicity, science achievement, and attitudes.*Journal of Research in Science Teaching,* 33(8): 901-933.

[32] Gros, B., 2002. Constructivism and Designing Virtual Learning Environment.*Society for Information Technology and Teacher Education*, 950-954. *https://www.learntechlib.org/p/10638/*

[33] Hewson, P. W., 1992.*Conceptual change in science teaching and teacher education*, *Documentation, and Assessment*.National Center of Educational Research,Spain.

[34] Hobbs, E. D. & Ericson, G. L., 1980. Results of the 1978 British Columbia science assessment.*Canadian Journal of Education*, 8: 36-47. *http://eric.ed.gov/?id=EJ222327*

[35] Hupper, J., Lomask, S. M., &Lazarowitz, R., 2002. Computer simulations in the high school: Students' cognitive stages, science process skills and academic achievement in microbiology. *International Journal of Science Education,* 24: 803-821.

[36] Johnson, M. A., & Lawson, A. E., 1998. What are the relative effects of reasoning ability and prior knowledge on biology achievement in expository and inquiry classes? *Journal of Research in Science Teaching*, 35: 89-103.

[37] Johnstone, A. H., &Mahmond, N. A., 1980. Isolating topics of high perceived difficulty in school biology.*Journal of Biological Education*, 14: 163–166. *http://eric.ed.gov/?id=EJ235142*

[38] Kang, S., Scharmann, L. C., Noh, T., &Koh, H., 2005. The influence of students' cognitive and motivational variables in respect of cognitive conflict and conceptual change.*International Journal of Science Education*, 27: 1037-1058.

[39] Lawson, A. E. & Thompson, L. D., 1988. Formal reasoning ability and misconceptions concerning genetics and natural selection.*Journal of Research in Science teaching,* 25 (9): 733-746.

[40] Memon, G. R., 2007. Education in Pakistan: The Key Issues, Problems and the New Challenges. *Journal of Management and Social Sciences*, 3(1): 47-55. *http://biztek.edu.pk/qec/jbs/3.1/5.%20Education%20in%20Pakistan-The%20Key%20Issues,%20Problems%20and%20The%20New%20Challenges.pdf*

[41] Mikkila, M., 2001. Improving conceptual change concerning photosynthesis through text design, *Learn. Instr.,*11: 241–257. *http://www.elainegalvin.ie/wp-content/uploads/2014/09/Improving-conceptual-change-concerning.pdf*

[42] Neiswandt, M., 2006. Student affect and conceptual understanding in learning chemistry. *Journal for Research in Science Teaching*, 44 (7): 908–937. http://onlinelibrary.wiley.com/doi/10.1002/tea.20169/abstract

[43] Odom, A. L. & Kelly, P. V., 2001. Integrating Concept Mapping and the Learning Cycle to Teach Diffusion and Osmosis Concepts to High School Biology Students. John Wiley & Sons, Inc. *Science Education*, 85: 615–635.*http://serials.unibo.it/cgi-ser/start/en/spogli/df-s.tcl?prog_art=8556723&language=ENGLISH&view=articoli*

[44] Petty, R. E. &Cacioppo, J. T.,1981.*Attitude and persuasion.Classic and contemporary approaches*.Wm. C. Brown,Dubuque, IA.

[45] Petty, R. E., 1995.*Attitude Change. In A. Tesser (Ed.), advanced social psychology*. McGraw-Hill, New York.

[46] Postner, G. J., Strike, K. A., Hewson, P. W. &Gertzog, W. A., 1982. Accommodation of a scientific conception: Toward a theory of conceptual change. *Science Education*, 66 (2): 195-209.

[47] Prokop, P., Prokop, M., &Tunnicliffe, S.D., 2007. Is biology boring? Student attitudes toward biology.*Journal of Biological Education*, 42(1): 36-39. *http://www.zoo.sav.sk/prokop/articles/Prokop%20et%20al.%20Boring%20BiologyJBE2007.pdf*

[48] Rahman, F., 2011.*Assessment of Science Teachers Metacognitive Awareness and Its Impact on the Performance of Students*.Unpublished doctoral dissertation,Allama Iqbal Open University,Islamabad.

[49] Resnik, L., 1983. Mathematics and science learning: A new conception. *Science*, 220: 477-478. *http://www.ncbi.nlm.nih.gov/pubmed/17816206*

[50] Richardson, V., 2003. Constructivist pedagogy.*Teachers College Record*, 105 (9): 1623–1640. *http://www.users.miamioh.edu/shorec/685/readingpdf/constructivist%20pedagogy.pdf*

[51] Safdar, M., 2007.*A Comparative Study of Ausubelian and Traditional Methods of Teaching Physics at Secondary School Level in Pakistan*.Unpublished doctoral Dissertation, National University of Modern Languages,Islamabad.

[52] Saşmaz, F. &Tezcan, R., 2009. The Effectiveness of the Learning Cycle Approach on Learners' Attitude toward Science in Seventh Grade Science Classes of Elementary School.*Elementary Education Online*, 8(1): 103-118.

[53] Scharmann, L. C., 1991. Teaching Angiosperm Reproduction by means of the learning cycle.*School Science and Mathematics*, 91(3): 100-104.

[54] She, H. C., 2005. Promoting students' learning of air pressure concepts: The interrelationship of teaching approaches and student learning characteristics.*The Journal of Experimental Education*, 74: 29-51.

[55] Shepardson, D. P., &Pizzini, E. L., 1994. Gender, achievement, and perception toward science activities.*School Science and Mathematics*, 94: 188-193.

[56] Simpson, R. D., & Oliver, J. S., 1990. A summary of major influences on attitude towards and achievement in science among adolescent students.*Science Education*, 74(1): 1-18.

[57] Simpson, W.D., Koballo, T. R., Oliver, J. S., & Crawley, F. E., 1994.*Research on the affective dimension of science learning. In D. L. Gabel, (Ed.), Handbook of research on science teaching and learning*. MacMillan,New York.

[58] Stables, A., 1990. Differences between pupils from mixed and single-sex schools in their enjoyment of school subjects and in their attitudes to science and to school.*Educational Review*, 42 (3): 221-230.

[59] Stepans, J., Dyche, S. &Beiswenger R., 1988. The effect of two instructional models in bringing about a conceptual change in the understanding of science concepts by prospective elementary teachers, *Science Education,* 72: 185–195.

[60] Strike, K. A., 1983.Misconceptions and conceptual change: Philosophical reflections on the research program. *International Seminar on Misconceptions in Science and Mathematics*, *Cornell University*, 67-78.

[61]Tekkaya, C.,2003. Remediating High School Students' Misconceptions Concerning Diffusion and Osmosis through Concept Mapping and Conceptual Change Text.*Research in Science and Technological Education*, 21 (1): 5-15.

[62]Thompson, J., &Soyibo, K., 2002. Effects of lecture, teacher demonstrations, discussion and practical work on 10th graders' attitudes to chemistry and understanding of electrolysis.*Research in Science and Technological Education,* 20: 25-37.

[63]Vighnarajah, Luan, & Bakar, 2008. The Shift in the Role of Teachers in the Learning Process.*European Journal of Social Sciences,* 7(2): 33-36.

[64]Webster, B. J. & Fisher, D. L., 2000. Accounting of variation in science and mathematics achievement.A multilevel analysis of Australian data. Third International Mathematics and Science Study (TIMS). *School Effectiveness and School Improvement*, 11: 339-360.

[65]Weinburgh, M., 1995. Gender differences in student attitudes toward science: A meta-analysis of literature from 1970 to 1991. *Journal of Research in Science Teaching,* 32 (4): 387-398.

[66]Wilder, M. &Shuttlewoth, P., 2005. Cell Inquiry: A 5E learning cycle lesson.*Science Activities*, 44 (4): 37-43.

[67]Yara, O, P., 2009. Students' attitude towards mathematics and academic achievement in some selected secondary schools in South Western Nigeria. *European Journal of Scientific Research*, 36 (3): 336-341.

[68]Zareen, R., Kayani, M. M. and Kayani A., 2014. Higher Secondary Biology Instruction in Pakistan in Constructivist Perspectives.*Bulletin of Education and Research*. 36(2): 39-56.