Iğdır Üniversitesi Fen Bilimleri Enstitüsü Dergisi
Iğdır University Journal of the Institute of Science and Technology

Context Based Learning' Effects on Achievement and Scientific Process Skills in Biology Teaching

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ABSTRACT: The purpose of this study was to investigate the effects of context-based learning approaches to teaching biology on students' achievement and scientific process skill. Quasi-experimental design with pre-post test control group was employed in this study. Context based approach was used for experimental group of 41 students, and the control group of 53 students were exposed to traditional learning approach by the same teacher over a period of 8 weeks in department of elementary school education. Academic science achievement test and scientific process skill test were given to both groups as pre-test and post-test. It was observed in the results that there was a meaningful difference between context based learning and traditional in learning on student's success and student's scientific process skill.

Keywords: Context based learning approach, Biology, Elementary school education, Achievement, Scientific process skill

Biyoloji Öğretiminde Başarı ve Bilimsel Süreç Becerilerine Yaşam Temelli Öğrenmenin Etkileri

ÖZET: Bu çalışmanın amacı "yaşam temelli öğrenme" yaklaşımının biyoloji öğretiminde öğrenci başarıları ve bilimsel süreç becerileri üzerine etkilerini araştırmaktır. Bu amaç için ön-son test kontrol gruplu yarı deneysel desen kullanılmıştır. Sınıf öğretmenliği bölümünde, aynı öğretmen tarafından 8 haftalık bir süreçte 41 kişilik deneysel gurupta yaşam temelli yaklaşım kullanılırken, 53 kişilik kontrol grubunda geleneksel öğretim yaklaşımı kullanılmıştır. Başarı testi ve bilimsel süreç becerileri testi her iki gruba da ön test ve son test olarak uygulanmıştır. Sonuçlarda, başarı ve bilimsel süreç becerileri açısından yaşam temelli ve geleneksel öğretim yapılan gruplar arasında anlamlı farklar gözlenmiştir.

Anahtar Kelimeler: Yaşam temelli öğrenme yaklaşımı, biyoloji, sınıf öğretmenliği bölümü, başarı, bilimsel süreç becerileri

Cilt: 3, Sayı: 4, Sayfa: 33-41, 2013
Volume: 3, Issue: 4, pp: 33-41, 2013

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Geliş tarihi / *Received:* 20.06.2012
Kabul tarihi / *Accepted:* 09.05.2013

INTRODUCTION

To improve the quality of the teaching-learning process as well as the learning outcomes, primarily the nature of learning has to be considered. Many learning theories and models have been developed by using different approaches to learning until today. Context based approach has been widely used a lot of country: United Kingdom, USA, Germany, Israel, Netherlands et al. (Bennett and Holman, 2003); Pilot and Bulte, 2006; Gilbert, 2006.)

Throughout the world, over the past 20 years or so, science education has faced a number of inter-related problems: Overload, Isolated Facts, Lack of transfer, Lack of relevance, adequate emphasis. Each of these problems poses a series of challenges. A major address to these challenges has been through the use of "context" as the basis for curriculum design and classroom teaching. For this to be successful, the educational model that embodies the meaning of "context" must be such that it provides an effective answer to the associated curricular and social problems. The word originates from the Latin language in the verb "contexere", "to weave together". In its related noun "contextus", the word expresses "coherence", "connection", and/or "relationship". A context must provide a coherent structural meaning for something new that is set within a broader perspective (Gilbert, 2006).

Contexts include personal, social, economic, environmental, technological and industrial applications of science. Contexts are normally selected on the basis of their relevance to students' everyday life, as perceived by teachers and educators. One outcome of adopting a context-based approach is that scientific ideas are introduced on a 'need to know' basis. In other words, they are needed to help develop understanding of features of the particular context being studied (Bennett et al. 2005). The contexts chosen for the course are topical and of interest to students, but are also enduring. There is a wide variety of learning activities including a range of practical work. Some activities involve model-building. Other activities include debates, discussions, research and role plays (SNAB).

'Student-centered' or 'active learning' approaches give students a significant degree of autonomy over the learning activity. Examples of 'active learning' activities include small-group discussions, group and individual problem-solving tasks, investigations and role-play exercises. The use of 'student-centered', 'active learning' approaches also stimulates interest and motivation (Bennett et al., 2005). There is a wide variety of learning activities including a range of practical work. Employing a wide range of teaching and learning styles, activities introduce both content and experimental techniques. The activities are also designed to develop wider skills including data analysis, critical evaluation of information, communication and collaborative work (SNAB).

There are three types of pedagogical activities. Those activities identified as "Your Turn" are fairly standard, straightforward drills and exercises, often involving simple mathematics. Their major purpose is to review scientific content, concepts, and calculations. Some of the Your Turn problems include solutions or at least answers, and thus they serve as instructional examples. "Consider this" activities relate more to the applications of scientific and the social issues under consideration. Most are open-ended and usually without a single "right" answer. Students may be asked to engage in risk–benefit analysis, to evaluate opposing viewpoints, to speculate on the consequences of a particular path of action, or to formulate or defend a position. In "The Sceptical Chemist" students are challenged to exercise their knowledge of science and their capacity for critical thinking to check the accuracy and plausibility of assertions, especially those reported in the press (Schwartz, 2006).

Consequently, scientists see an educational context to have four attributes:

a) A setting, a social, spatial, and temporal framework within which mental encounters with focal events are situated;

b) A behavioral environment of the encounters, the way that the task(s), related to the focal event, have been addressed, is used to frame the talk that then takes place;

c) The use of specific language, as the talk associated with the focal event that takes place;

d) A relationship to extra-situational background knowledge (Gilbert, 2006).

The majority of studies of the effects of context-based approaches to teaching science on students' understanding have been comparative in nature, looking at the understanding of selected scientific ideas demonstrated by students who have followed context-based courses and students who have followed more conventional courses (Bennett and Holman, 2003). Bennett and Lubben (2006) indicate that students adapted to the context-based approach develop levels of understanding of chemical ideas comparable with those taking more conventional courses.

In another study, context-based approach has been practiced in teaching several control engineering courses in a university with promising results, particularly in view of student learning performances (Dong, 2005). Gutwill-Wise (2001) worked with university students following introductory chemistry courses. He compared students who had followed the context-based approach with matched groups of students who had followed a traditional approach to chemistry. The study found that in both institutions students who had followed the context-based approach emerged with a better understanding of chemistry than their peers who had followed a traditional approach.

King et al. (2007) reported real-world connections between chemistry concepts and contexts, found her engagement in the context-driven tasks interesting and productive, and identified connected sequences of concepts across the contexts studied. Despite difficulties for teachers who are required to shift pedagogies, the student's lived experiences and outcomes from a context-based program provide some encouragement in working through these issues. Kegley et al. (1996) compared to the regular laboratory students, the environmental students also displayed a greater awareness of the relationship of chemistry to everyday life and a more sophisticated view of science.

From scientists discussions and preliminary outlines, for context based learning six goals emerged:

- To motivate students to learn science and understand its societal significance.
- To teach them fundamental concepts of science.
- To lead them to discover the theoretical and practical significance of science.
- To equip them to locate information and address technical issues.
- To develop analytical skills, critical judgment, and the ability to assess risks and benefits and evaluate information.
- To provide hands-on experience with scientific phenomena (Schwartz, 2006).

These aims of context based learning have indicated that it will be able to development scientific process skill of students. Science process skills include observing, classifying, measuring, communication, inferring, predicting, using time and space relationships, using numbers, recorded of data, using of data and forming model, interpreting data, to draw a conclusion, naming and controlling variables, formulating hypothesis, making operational definitions, experimenting, investigating (Tan and Temiz, 2003; Harlen, 2000). The pupils need the process skills both when doing scientific investigations and in their learning process (Harlen 2000; Taconis et al. 2000). Science process skills enable learners to learn how to learn by thinking critically and using information creatively (Martin et al. 1994).

Purpose of Study

The purpose of this study was to investigate the effects of context-based approaches to teaching biology on students' understanding and scientific process skill by comparative students who have followed context-based courses and students who have followed more conventional courses. Research hypothesizes are: 1- H_0: there is a significant difference between the intervention group (experimental group) and the control group in the amount of change that occurs over time in the undergraduates' achievements of the chosen five biology topics. 2- H_0: there is a significant difference between the intervention group (experimental group) and the control group in the amount of change that occurs over time in the undergraduates' scientific process skill.

METHOD

Research Design

In the research, quasi-experimental nonequivalent pretest-posttest control group was used. This design is very prevalent and useful in education, since it is often impossible to randomly assign subjects. In the design, the researcher uses intact, already established groups of subjects, gives a pretest, administers the treatment condition to one group, and gives the posttest (McMillan and Schumacher, 2001). Repeated measures MANOVA and t test were chosen as statistical analysis techniques. While the separate repeated measures MANOVA was performed for the data collected for the five biology topics, scientific process skill scores was assessed using t test. Experimental design is seen Table 1.

Table 1. Experimental Design

Group	Pretest	Intervention	Posttest
R_1	0	X	0
R_2	0		0

R_1: Experimental group
R_2: Control group

Participants

This study was applied to two groups' first grade students that include 53 students in control group and 41 students ranging age of 17 to 19 in experimental group in department of elementary learning education in Bayburt Education Faculty of Ataturk University at the first semester of 2007-2008 education years. Classes were randomly assigned as experimental (class 1) and control (class 2) group.

Procedure

The data from the subjects were collected in the following manner:

Two weeks ago from the treatment, the achievement tests developed by the researchers and scientific process skill test were administered to experimental and control groups as pre-test. While used only the traditional teacher centered instruction in the control group, context-based learning was used in the experimental group. The traditional instruction was based on lecturing in class. It was not designed explicitly to facilitate conceptual understanding or conceptual change. All treatment was completed by the same teacher in 8 weeks (two lecture hours per week and a lecture hours is 50 min). One week later after the treatment with respect to the corresponding topic, the achievement test of these topics was administered to both control and experimental group as post-test. After 8 week, scientific process skill test was administered to experimental and control groups as post-test.

Contexts

The contexts require quite simple that students may meet in daily life. Story-style contexts are structured around social and environmental issues related to biology rather than around predetermined biological concepts. For example, AIDS, influenza used as a context to develop an extensive range of foundation biology, including structure properties, reproductive cycles, viral diseases, type of virus. The activities began with contexts. Teacher introduces contexts. Questions and problems connection with contexts were offered students. Small group sessions, large group workshop, laboratory working, individual researches, team working, short demonstrations and video-clips were used in lesson as a different kind of context. The activities finished generalization and students' feedback. In Table.2, topics' contexts, concepts and time are showed.

Table 2. Topics' Contexts, Concepts and Time

		Contexts	**Basic concepts**	**Time**
Virus		Alive and lifeless discussion, AIDS disease	Structure properties, reproductive cycles, viral diseases, type of virus	1. Week
Bacteria		They are almost everywhere!, Making of Yogurt	Structure properties, reproductive cycles, type of bacteria, economy of bacteria	2. Week
Fungi		Ecologic workers, Making of Bread	Body structure, reproductive cycles, type of fungi, fungi in ecosystem	3. Week
System-I	Movement system	Asimo run robot	Type and function of skeletons, muscle. Mechanism of movement.	4. Week
	Digestive system	Obesity, Cows that eat green gress and produce white milk	Organs of digestive system, main stages of digestion	5. Week
System-II	Circulatory system	Heart attack, heart massage	Structure of heart and blood vessel, blood circulation	6. Week
	Respiratory system	Smoke	Structure of lungs, breathing, gas exchange.	7. Week
	Excretory system	Dialyzer, Kidney stone, drink beer frequently urinate	Structure of kidney, nephron and urine, main stages of excretory,	8. Week

Data collection tools

Measuring of Students' achievement about the five biology topics.

Students' achievement of biology was measured using the five multiple choice test developed separately for each topic by researchers. The tests were piloted with a group of students in department of elementary learning education in Bayburt Education Faculty of Ataturk University at the second semester of 2006-2007 education years. Then modifications were made in terms of language and design of the test. The virus test has 0.7172, the bacteria test has 0.7776, the fungi test has 0.6476, the system-I has 0.7824, the system-II has 0.7158 α reliability coefficient. This level of reliability coefficient obtained for the achievement test indicated that the test could be considered satisfactorily reliable (McMillan and Schumacher 2001). The validity of multiple choice academic science achievement tests were supplied by two professors of science education and three science teachers. The five biology topics tests has totally 107 questions and any question is a one point. The range of possible total scores for achievement test is between 0 and 107.

Scientific Process Skill Test (SPST)

The scale of scientific process skill was developed by Okey et al.(1982) and adapted into Turkish by Geban et al. (1992). It was used to control the effect of science process skills on achievement. Five different science processes were measured on the SPST: (1) identifying variables, (2) identifying and stating hypotheses, (3) operationally defining, (4) designing investigations, and (5) graphing and interpreting data. The SPST is a 36 multiple choice item instrument that includes the five aforementioned dimensions. The Cronbach alpha reliability coefficient of the Turkish version of this instrument is 0.81 (Doğruöz, 1998).

RESULTS

Undergraduates' achievements of the five biology topics

Table 3. Means and Standard Deviations

	Groups	Mean	SD	N	Skewness	Kurtosis
Virus pre test	Experimental	1.56	0.87	41	-0.317	-0.265
	Control	1.52	0.84	53	-0.354	-0.208
	Total	1.54	0.85	94		
Virus post test	Experimental	9.12	2.85	41	-0.409	-0.078
	Control	5.55	2.50	53	0.203	-0.767
	Total	7.11	3.19	94		
Bacteria pre test	Experimental	1.08	0.89	41	0.510	-0.025
	Control	1.16	0.96	53	0.429	-0.380
	Total	1.12	0.93	94		
Bacteria post test	Experimental	9.05	2.06	41	-0.465	-0.641
	Control	6.53	2.68	53	0.261	-0.191
	Total	7.63	2.72	94		
Fungus pre test	Experimental	2.90	2.17	41	0.473	-0.724
	Control	3.08	2.17	53	0.355	-0.835
	Total	3.00	2.16	94		
Fungus post test	Experimental	6.39	2.01	41	-0.665	0.968
	Control	4.57	2.24	53	-0.730	-0.360
	Total	5.36	2.32	94		
System1pre test	Experimental	1.63	1.05	41	-0.111	-0.456
	Control	2.52	0.52	53	0.467	0.848
	Total	2.13	0.91	94		
System 1 post test	Experimental	9.27	2.57	41	-0.081	-0.756
	Control	5.94	2.50	53	0.136	0.002
	Total	7.39	3.01	94		
System 2 pre test	Experimental	1.76	0.99	41	-0.487	-0.086
	Control	3.07	0.65	53	0.352	0.241
	Total	2.50	1.04	94		
System 2 post test	Experimental	12.54	3.30	41	0.357	0.545
	Control	6.42	2.81	53	0.209	-0.384
	Total	9.09	4.29	94		

Repeated measures MANOVA was conducted to assess if there was a difference between participants in the intervention group and participants in the control group over time in the amount of change in their scores on the biology achievements. Before the analysis, it was checked whether the assumptions of repeated measures MANOVA were met. Box's M test for the homogeneity of the covariance matrices indicated that the homogeneity of the variance matrices of dependent variables was met (Box's M = 82.36; F=1.32; df1=55, df2=23936; p= 0.056>0.05). In addition, Levene's test for homogeneity of variances showed that the variances can be assumed as homogeneous because of the significance levels ranging from 0.056 to 0.81. The box plots created to explore whether the outliers are present in data showed that there were outliers at seven data points. These outliers was replaced the mean of data set. The symmetric shapes observed in the box plots and the skewness and kurtosis values changing between -1 and +1 (see table 3) indicated that normality assumption of raw scores may be accepted. The mean scores and standard deviations of data for each dependent variable according to groups are presented in Table 3.

Repeated measures MANOVA indicated there were the significant multivariate effects of group, Wilks'λ=0.461, F(5.88) = 20.54, η^2=0.539 p=0.000 and time, Wilks'λ =0.049, F(5.88) = 343.99, η^2=0.951, p=0.000, as well as for the interaction between group and time, Wilks'λ=0.275, F(5.88) = 46.29, η^2=0.725 p=0.000 according to liner combination of dependent variables. Because Box test about equality of covariance matrix of dependent variables meets the requirements of this, Wilks'λ statistic was chosen as an appropriate statistic. In other words, the results mean that according to the liner combination of dependent variables, the difference between control and experimental group differs from pre-test to posttest. The interaction effect indicated that the difference between the experimental and control group on the linear combination of the five dependent variables was different at pretest than it is at posttest. The values of η2 (eta squared) for group main effect, time main effect and interaction effect are quite high. The corresponding eta values are 0.734, 0.975 and 0.851, which are very large effects. To determine which levels of dependent variables these differences are, follow-up ANOVAs (Test of within subject contrasts) for each dependent variable (see Table 4) were conducted. As can be seen from this table, the main effect of time (change from pretest to posttest) is significant for all five dependent variables and also the interaction between group and time are statistically significant for all dependent variables. This indicates that the change over time is associated with the intervention. Moreover, the profile plots were created separately for each dependent variable clearly to reveal the statistically significant time-group interactions (Figure 1-5). As seen in figures 1-5, the lines of experimental and control groups are nonparallel and the slopes of lines are dissimilar. It is clear from the profile plots that there are the significant increases in posttest scores in comparison with pretest scores for all five dependent variables. Again, it can be inferred from all plots that the increase in the posttest scores of the experimental group is higher than that of the control group and the difference between the groups is also statistically significant, suggesting the developing effect of the intervention in comparison with control group. The values of η^2 (eta squared) for time main effect and interaction effect indicating the practice significance of the factor or interaction change from 0.116 to 0.866. The lowest values (0.116 and 0.197) belong to the topic fungus and bacteria in the time-group interaction, respectively. The corresponding Eta values are 0.34 and 0.44 which are about medium and large effect sizes, respectively.

Table 4. Test of Within Subject Contrasts

		Sum of Square	**Freedom degree**	**Mean of Square**	**F**	**p**	**η^2**
Time	Virus	1550.739	1	1550.739	415.378	0.000	0.819
	Bacteria	2056.735	1	2056.735	595.269	0.000	0.866
	Fungus	286.468	1	286.468	74.927	0.000	0.449
	System1	1413.872	1	1413.872	406.034	0.000	0.815
	System2	2306.354	1	2306.354	492.696	0.000	0.843
Time* Group	Virus	144.714	1	144.714	38.763	0.000	0.296
	Bacteria	77.801	1	77.801	22.518	0.000	0.197
	Fungus	46.106	1	46.106	12.059	0.001	0.116
	System1	205.298	1	205.298	58.957	0.000	0.391
	System2	638.29	1	638.290	136.355	0.000	0.597

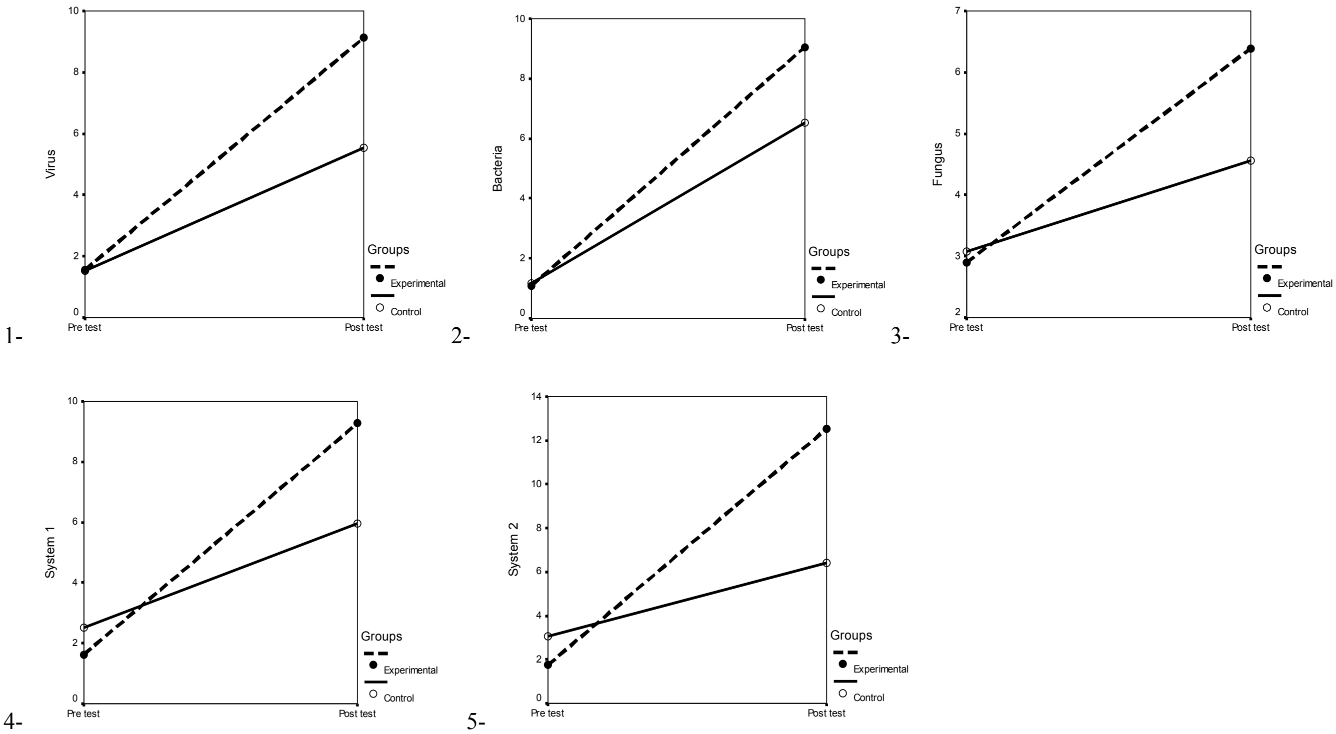

Figure 1-5. Profile plots of dependent variables

Undergraduates' Scientific Process Skill

A t test was used to see if experimental group and control group scientific process skill. First, to explore whether there is a significant difference between experimental and control groups with respect to scientific process skills prior to the treatment, t test was performed. The findings are given in Table.5.

Tablo 5. Between Experimental and Control Groups Students' Pre Test Scores

Group	N	Mean	df	t	P
Experimental Group	41	20.05	3.77	1.137	.260*
Control Group	53	18.93	4.29		

*p>0.05

T test showed no significant differences between experimental and control groups. Pre practice, mean pre test of experimental group is calculation as 20, 05 and mean pre test of control group is 18. 93. The differences among experimental and control groups on post practice were measured by t test. The results are given in Table.6.

Tablo 6. Between Experimental and Control Groups Students' Post Test Scores

Group	N	Mean	df	t	P
Experimental Group	41	20.30	3.89	7.357	.000*
Control Group	53	11.60	5.75		

*p<0.05

The p-value .000, less than 0.05, indicates that there is significant different between experimental and control groups. A scientific process skill of experimental group is higher than scientific process skill of control group.

DISCUSSION

In accordance with the first research hypothesis, there are significant differences between experimental and control group students regarding their academic achievement. Repeated measures MANOVA revealed that there are significant differences in favour of experimental group students (Table.4). Time * Group has statistically significant F ratios for five biology subject (virus F=38.763, p=0.000, partial η^2=0.296; bacteria F=22.518, p=0.000, partial η^2=0.197; fungi F=12.059, p=0.001, partial η^2=0.116; system-I F=58.957, p=0.000, partial η^2=0.391; system-II F=136.355 p=0.000, partial η^2=0.597). The experimental group students' academic achievement is higher than the control group's (Table 3, Figure1-5). This difference may be the result of contexts used by experimental group students.

Context-based approach is gaining popularity throughout the world. The results of this investigation support the findings of several recent studies. Context based learning indicate positive effects the teaching and learning situation in the classroom and the professional development (Nentwig et al. 2007). Holman and Pilling (2004) suggest that the context based course succeeded in increasing students' interest. The results are backed up by a comparison of the two groups of students' performance: the average mark was 48.5% with the traditional course in 2000 and 61.3% with the context based course in 2001. Gutwill-Wise (2001), Bennett and Lubben (2006), Murphy and Whitelegg (2006) indicate that students who had followed the context-based approach emerged with a better understanding of science than their peers who had followed a traditional approach.

In accordance with the second research hypothesis, there is difference between these groups regarding scientific process skill test. First, there isn't a significant difference between experimental and control groups with respect to scientific process skill prior to the treatment and p=0.260 (Table.5). The differences among experimental and control groups on post practice were measured by t test. There are significant differences in favour of experimental group students p=0.000 (Table.6). This difference may be the result of contexts used by experimental group students. Scientific process skills can be developed in a real-life environment closer to that of practicing scientists (Chiu, 2002). Context-based approach creates opportunities in the classroom for connections between biology concepts and the real world (Bennett, 2003).

Context based approach motivate students to learn science and understand its societal significance, teach them fundamental concepts of chemistry, lead them to discover the theoretical and practical significance of chemistry, equip them to locate information and address technical issues, develop analytical skills, critical judgement, and the ability to assess risks and benefits and evaluate information, provide hands-on experience with chemical phenomena (Schwartz, 2006).

Student comments indicated that context based approach supplied a broadened perspective on the nature and process of science and were more critical of data obtained using scientific methods (Kegley et al., 1996). The student reported real-world connections between chemistry concepts and contexts, found her engagement in the context-driven tasks interesting and productive, and identified connected sequences of concepts across the contexts studied. Despite difficulties for teachers who are required to shift pedagogies, the student's lived experiences and outcomes from a context-based program provide some encouragement in working through these issues (King et al. 2007).

CONCLUSIONS

The aim of this study is to determine effect of context based learning towards student's biology success and student's scientific process skill. We found that students in experiment group emerged with a better understanding of biology than their peers in control group. Scientific process skill surveys found that students in experiment group have more scientific process skill than students in control group. They thought that the learning method was effective, especially in comparison to the more traditional. Moreover, context based approach encourages group work and some additional skills such as discussion, problem-solving, individual researches, team working and self directed leaning skills. We are encouraged by the results of the context based approach and believe it provides a formula for increasing the scientific process skill and understanding of a biology subject without sacrificing rigor or quality of learning. The context based approach is regarded as being appropriate to achieve these objectives.

Context-based approach has demonstrated their utility and is generally well established. As a result of these findings, it may advise to teach of biology using context materials. Because increasing scientific process skill and understanding for learning biology is the reason for using this approach, appropriate contexts for students should be selected. Teachers might give well-defined research problems, completed questions, obvious hypotheses, receipt-like methods, and needed equipment to the pupils in order to save time. Teachers should offer pupils the possibility to plan their own investigations, where they make their own questions and hypotheses, choose methods and necessary equipment, discuss about the means for ensuring reliability and the ways of scientific reporting. In that way the pupils can adopt scientific skills, which mean learning some fundamental features of the nature of science, and, consequently, even deepen their conceptual understanding of natural phenomena.

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