Sequential Teaching Methods In Biology And Their Effects In Academic Achievement

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Abstract

The purpose of this paper was to determine the effects of usage of sequential teaching method on the academic achievement and retention level of students. Three student groups, each of which included 20 biology students in Ataturk University-Erzurum, were offered a topic on general characteristics of enzymes with different sequences of 3 teaching methods. The teaching methods were Laboratory method (student experiment), slide demonstration and lecture method. The first group started to course with experiments in the laboratory, then the relevant theory of enzyme was given lecture method, and then the slides was shown (Group I). The sequence of these three teaching methods used in the first group was changed in both second and third group as follow: The lecture methods, slide show and experiment in Group II, and slide show, experiment and lecture method in Group III, respectively. Lab method used in the study was focused on the topic of enzymic activity. a student experiment was designed for this reason, and including to examine its catalytic features, effective factors, and relation between substrate and enzymes. This experiment was carried out by students. Slide demonstration method included slides about enzyme structure and function. The slides were shown by teachers. Lecture method was performed by teachers as usual. Effectiveness of different sequential teaching methods was measured quantitatively by an achievement test. Achievement test contained 25 questions, testing the knowledge of facts as well as the ability to transfer the knowledge and problem solving ability. This test was used as pre-test before methods' application, post-test after the methods' application and retention test after 40 days from methods' applied. Tests' results were evaluated by using one way ANOVA test. According to tests' results, academic achievements of student in Group I and Group III were higher than academic achievements of student in Group II. Student's retention (remembrance) level in Group I was higher than that of Group II and Group III.

Key words: Slide demonstration, laboratory, lecture method, teaching methods, sequential teaching methods.

Biyolojide Sıralı Öğretim Metodları Ve Akademik Başarı Üzerine Etkisi

Özet

Bu çalışmanın amacı biyoloji öğretim metotlarının kullanım sırasının öğrencilerin akademik başarısında ve hatırlama seviyelerindeki etkisini belirlemektir. Bu amaçla birinci sınıf Atatürk üniversitesi biyoloji öğrencilerinden 20 kişi içeren 3 grup üzerinde 3 öğretme metodunun kullanım sırası değiştirilerek enzim konusunun genel karakteristiği anlatılmıştır. Öğretim metotları laboratuar uygulaması, gösteri (slayt, demonstrasyon) ve düz anlatımdır. Birinci grup derse laboratuar da deney ile başladı, sonra enzim konusu ile

ilgili teorik bilgi düz anlatım ile verildi ve sonra slayt gösterildi (Grup I). Birinci grupta kullanılan bu üç öğretim metodunun sırası ikici grupta değiştirildi. İkinci grupta ders düz anlatım ile başlatıldı, sonra slayt gösterisi kullanıldı ve en son öğrenciler tarafından deney yapıldı (Grup II). Üçüncü grupta yine bu üç öğretim metodunun sırası değiştirildi ve ders slayt gösterisi ile başlatıldı, sonra deney yapıldı ve en son düz anlatım yapıldı (Grup III). Laboratuar uygulaması, enzimlerin katalitik özellikleri, çalışmalarına etki eden faktörleri ve enzim-substrat ilişkisini kapsayan, katalaz enzimi ile yapılan bir öğrenci deneyidir. Bu deney öğrenciler tarafından yürütüldü. Gösteri ise enzimin yapısını ve fonksiyonlarını gösteren slaytlar şeklindedir. Bu slaytlar öğretmen tarafından sınıfa gösterildi. Düz anlatım ise öğretmen tarafından bir konferans niteliğinde sunulur. Değişik sıralı metotların etkisi bir başarı testi ile nicel olarak ölçüldü. Başarı testi, 25 maddelik olup bilgi yanında, bilginin transferi ve problem çözme yeteneğini ölçmektedir. Bu test örneklem gruplarına konu sunulmadan önce ön test, konu sunulduktan sonra son test ve son testten 40 gün sonra kalıcılık (hatırlama) testi olarak üç kere uygulanmıştır. Sonuçlar tek yönlü varyans analizi testi kullanılarak değerlendirilmiştir. Testten elde edilen sonuçlara göre, Grup I ve Grup III 'ün akademik başarıları Grup II' nin akademik başarısından daha yüksektir. Grup I' deki öğrencilerin kalıcılık düzeyleri ise Grup II ve Grup III' deki öğrencilerin kalıcılık düzeylerinden yüksektir.

Anahtar Kelimeler: Slayt gösterimi, laboratuar, düz anlatım, öğretim metotları, sıralı öğretim metotları

Introduction

Biology teaching must reflect the exciting nature of the subject and its surroundings. Student work in biology lessons should be practical and visual in nature wherever possible (YOK, 1996). In actual fact, teachers often use only lecture method (without visual aids or demonstrations) in biology lesson in general. There has been a number of researches on the effectiveness of different teaching methods in biology lessons (Galton and Eggleston 1979; Holstein and Lunetta 1982; Johnson 1991; Odubunmi and Balogun, 1991; Killermann, 1998), and especially methods of laboratory and slide demonstration are considered to be very effective in biology teaching. But, these methods must be used in an appropriate sequence. The Methods used in this study will be explained briefly.

Lecture method

The traditional didactic lecture method as "an oral presentation given to a class by the teacher" (p. 31), while Ericson (1960) stated that the lecture or didactic is the method of teaching outside of manipulative work. Teachers are comfortable with the traditional method because they remain in control of content and time (Havice, 1999).

Evidences from a number of disciplines suggest that oral presentation to a large group of passive students contributes very little to real learning. In physics, standard oral-lecture does not help most students develop conceptual understanding of fundamental processes in electricity and in mechanics. Similarly, student grades in a large general chemistry oral-lecture course do not correlate with the lecturing skills and experience of the instructor. Despite the limitations of traditional oral-lectures, introductory courses in biology are forced to offer high-enrolment introductory science courses. Many professors who teach these courses feel that lecturing is their only option, and can only dream of what they could accomplish in smaller classes (Committee on Undergraduate Science Education, 1997). However, there is a small but growing group of science faculty members who have developed ways to engage students in the process of thinking, questioning, and problem solving despite the large class size (Committee on Undergraduate Science Education, 1997).

Slide demonstrations

A slide demonstration is an act that a teacher shows and explains something to a class by a prepared ppt teaching tool in Microsoft office software or classically via overhead. This can be used as any educational materials.

Carefully material-selected slide demonstrations are one of the ways of helping students overcome misconceptions, and there are a variety of resources available (Katz, 1991). Slide demonstrations can be very effective for illustrating concepts in the class, but can result in passive learning without careful attention to engaging students. They can provoke students to think by themselves and are especially helpful if the slide demonstration has a surprise, challenges an assumption, or illustrates an otherwise abstract concept or mechanism. Slide demonstrations that use everyday objects are especially effective and require little preparation on the part of faculty. Students' interest is peaked if they are asked to make predictions and vote on the most probable outcome. There are numerous resources available to help faculty design and conduct slide demonstrations (Committee on Undergraduate Science Education, 1997).

Laboratory method (student experiment)

Laboratory work is the hallmark of education in science and technology based fields. Student laboratories are a costly resource yet their educational potential is often not fully realized in practice. It is timely that their design and delivery and the forms of student assessment used be examined critically for their contribution to high quality learning (Winter et al., 2001).

The first area of study is the effectiveness of laboratory activities for promoting learning. Practical work is a central theme of lessons in the natural sciences (Galton and Eggleston, 1979; Holstein and Lunetta, 1982).

Laboratory work is seen as an integral part of most science courses and offers students a learning environment that differs in many ways from the "traditional" classroom setting (Fisher et al., 1998).

It is important to consider whether learning is more effective if the students do the student experiments themselves or they watch the teacher demonstrating the student experiments. Furthermore, are either of these approaches more effective than the teacher simply describing the student experiments to the students and telling them the results? (Killermann, 1998).

It is hard to imagine learning about science, without doing laboratory or fieldwork. Student experimentation underlies all scientific knowledge and understanding. They provide students with opportunities to think about, discuss, and solve real problems. Developing and /carrying out/conducting/ an effective laboratory require as much skill, creativity, and hard work as proposing and executing a first-rate research project (http://www.queensu.ca/ctl/goodpractice/lab/strategies.html). No science can be properly taught without student experiments. The student experiment should be the central part of science teaching. It serves many purposes. Student experiments are performed to find relations among concepts or to verify hypothesis.

As in other lessons, in science lessons the effectiveness is related to the use of teaching methods. Some methods may use together for offering a topic. But, which method must take precedence to increase student academic achievement and retention (remembrance) level?

The aim of this study was to determine the effects of the usage sequential lecture method such as didactic lecture, slide demonstration and laboratory student experiment on the academic achievement and retention (remembrance) level in teaching of enzymes.

Academic achievement: Achievement meant that students have possessed immediately after finishing the lesson.

Retention (remembrance) level: Achievement meant that students' retain (remembrance) which is determined 40 days after finishing the lesson.

Research problem

How does the usage of sequence of teaching methods in science education effect the academic achievement and retention (remembrance)?

Sub problems of research

1. Are there any differences in academic achievement among the groups examined? (Group I-Group II, Group I-Group III, Group II-Group III).

2. Are there any differences in retention (remembrance) levels among the groups examined? (Group I-Group II, Group I-Group III, Group II-Group III).

Methodology

Sample

This study was designed as experimental and carried out with three student groups, each of which included 20 biology students in first year of Education Faculty, Ataturk University-TR.

Data Gathering Tools

The work was attempted to establish empirically whether the usage of sequential teaching methods was important for academic achievement and retention. The efficiency was determined quantitatively by a written test. This test contained 25 questions (added in Appendix) were selected from University entrance exams by the authors. This test was used as pre-, and post-test before and after methods' applications, and then retention test after 40 days from completing the study.

Procedure and Data Analysis

At first, a pre-test is administered to three groups that each one had 20 students. According to pre-test's results, differences among groups were analyzed statistically by using *one way ANOVA* test (Table I), and there was no significant difference (P>0.05) among them.

Table I. *one way -ANOVA test results of pre-test of groups*

Groups	N	Mean	S.D	f	Sigma
Group I	20	14.25	1.51		
Group II	20	13.85	1.59		
Group III	20	14.25	1.20		
	Sum of	df	Mean square		

	squares				
Between Groups	8.13	2	4.06	1.93	0.15
Within Groups	120.05	57	2.10		
Total	128.18	59			

Then, the general concepts and main knowledge of enzymes were taught using three methods in different sequences. The first group started with experiments in the laboratory, then the relevant theory of enzyme was given lecture method, and then the slides were shown by teacher. The sequence of these three teaching methods used in the first group was changed in the second group. In the second group, lesson was started with lecture methods, then used slide show and the latest experiment was done. The sequence of these teaching methods was also changed and the use of the slide show was initiated, then the experiment was done and the latest lecture method was used in third group.

The sequences of teaching methods for the three groups were as follows:

Group I: Student experiment – lecture method – slide demonstration.

Group II: Lecture method – slide demonstration – student experiment.

Group III: Slide demonstration – student experiment – lecture method.

The student experiment's aim was to provide a simple experiment to the students that enzymes' activity can be easily managed in class. In this experiment, students obtained hydrogen peroxide easily from green leave and a piece of liver. One gram each of freshly ground liver, crushed liver and cooked liver were separately placed in three test tubes with hydrogen peroxide (H_2O_2) solution. It was then tested whether a gas evolved in the tubes. Identifying the gas is oxygen.

In lecture method, a lecture presented orally on the general knowledge of enzyme without using any kind of media.

In slide demonstration, lecture was performed by showing slides that was containing the explanation of characteristics, structure and study principles of enzymes. Each teaching approach lasted in two hours.

Then, the same measure tool (pre-test) was applied to each group as post-test. Forty days after the lesson, it was repeated to each group as retention test. "Delayed retention tests" are research instruments which are administered two or more weeks after instruction and initial testing to measure retained knowledge (Haynie, 1997). Pupils never were aware of any further testing and these tests were not used for grading purpose to avoid the influence of extrinsic variables. Results were evaluated by using *one way ANOVA* test.

Results

Table II. *Comparisons among groups in point of post test.*

Groups	N	Mean	S.D	f	sigma	Tukey HSD
Group I	20	21.70	1.89	6.18		
Group II	20	19.70	1.80			

Group III	20	21.20	1.90			
	Sum of squares	df	Mean square			
Between Groups	43.33	2	21.66		.004	I-II III-II
Within Groups	199.60	57	3.50			
Total	242.93	59				

In Table II, according to *one-way ANOVA* test results, difference between Group I and Group II was statistically significant (P<0.05). This result suggested that, students' academic achievement level in Group I was higher than Group II students. This *one-way ANOVA* test results established that the difference among the groups' average was significant (P<0.05). This meant that, students' academic achievement level in Group III was higher than that of Group II.

Table III. *Comparisons among groups in point of view retention (remembrance) level*

Groups	N	Mean	S.D	f	Sigma	Tukey HSD
Group I	20	20.95	1.98			
Group II	20	19.35	1.66			
Group III	20	20.55	1.82			
	Sum of squares	df	Mean square			
Between Groups	27.73	2	13.86	4.15	.021	I-II
Within Groups	190.45	57	3.34			
Total	218.18	59				

As seen in Table III, the difference between Group I and Group II was significant (P<0.05). It meant that students' retention (remembrance) level in Group I was higher than Group II.

Discussion and Conclusion

The results of this study showed that academic achievement in lessons began with experiment or slide demonstration was higher than lesson beginning with lecture method. In science teaching, using laboratory student experiment or slide demonstration at the beginning of the lesson attracts attention and motivation of students. But, using oral-only lecture bores students and looses their attention to it. (https://www.asrt.org/Media/Pdf/ForEducators/4_Instructional Techniques/4.2Lecture.pdf). A visual material supplies comprehension that words cannot express alone and make students remember the contents of learning easily (Odubunmi and Balogun 1991; Gentry, 1994). A

laboratory setting is a more conducive learning environment than lecture halls (especially for large classes) as it provides students with real life situations and a chance to exercise their problem-solving skills. At the same time, students have more time and opportunities for hands-on experience, active thinking and knowledge reflection. In addition, a teamwork environment encourages students to practice their interpersonal skills as well as to nurture team spirit and leadership. Finally, oral presentations provide an opportunity for students to sharpen their mental response and presentation skills (http://www.cdtl.nus.edu.sg/link/mar2005/faculty.htm).

According to this study's results, retention (remembrance) level in lesson beginning with experiment and slide demonstration was higher than that of beginning with lecture. Because, people remembrance 10% of what they read, 20% of what they heard, 30% of what they saw and 90% of what they had a hands-on experience. Laboratory work is a hands-on experience (Beydogan, 2001).

This study has also showed that student comprehension can be enhanced with lesson started with experiment, because these activities increase students' interest in the topics.

It is hoped that this study would be a beginning on different sequential teaching methods in biology in Turkey. Furthermore, the results of the present study could be adapted to any other teaching cases.

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Appendix

Questions

1. Which of the following is *not* a feature of enzyme?
A) Enzymes lower the activation energy for chemical reactions.
B) Energy that must be added to get a reaction started, which is recovered as the reaction proceeds
C) Enzyme does not form chemical bonds with the substrate, it changed
D) The activity of enzymes is strongly affected by changes in pH
E) The activity of enzymes is strongly affected by changes in temperature

2. Enzymes:
A) are composed primarily of polypeptides, which are polymers of amino acids.
B) can bind prosthetic groups such as metal ions that participate in enzyme reactions.
C) have defined structures.
D) lower the activation energy for chemical reactions
E) all statements are true.

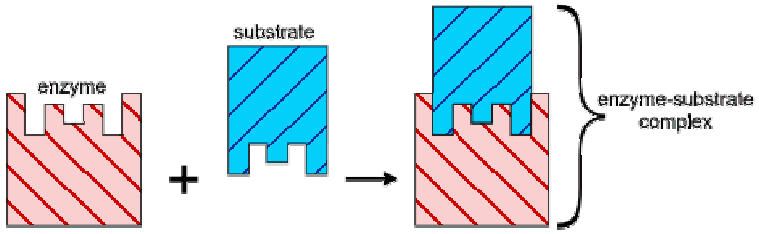
3. Which of the following is molecule **of** hydrolysis of all enzymes**?**
A) glucose
B) glycerin
C) nucleotide
D) amino acid
E) fatty acid

4 I The enzyme molecules become denatured at high temperatures
II Enzymes consist of a protein and a non-protein
III They are taken with foods
IV They can be used repeatedly
Which of the above are true for enzymes?
A) II and III B) III and IV C) I, II and II
D) I, II and IV E) I, III and IV

5. Which of the following are not true for enzymes?
A) The activity of enzymes is strongly affected by changes in pH
B) A enzyme can be work various co enzymes
C) Enzymes can be used ATP for enzyme-catalyzed reaction
D) Bind their substrates at active sites.
E) The enzyme structure begins to (denature) at high temperature.

6 Which of the following can explanation that enzymes are specific for one particular reaction?
A) Enzyme remains unchanged
B) The enzyme does not form a chemical bond with the substrate
C) Lowering the activation energy of the reaction
D) Lock and key relation with substrate This specificity is due to the shapes of the enzyme molecules.
E) They can be used repeatedly

7.



Which of the following explains above figure?
A) Enzymes are specific for one particular substrate
B) Enzymes are affected by changes in temperature
C) Enzymes require the presence of an additional, non-protein, cofactor.
D) Substrate concentration is effect the rate of reaction.
C) There is a certain temperature at which an enzyme's catalytic activity is at its greatest

8. I substrate name
II reaction name
III kind of reaction
Which of the above are used for to give a name to enzymes?
A) only I B)) only II C) I, II, III
D) I and II E) II and III

9. I water
II substrate surface
III ATP
IV temperature
Although the concentrations of enzyme and substrate are sufficient in an enzyme-catalyzed reaction, which of the above's insufficient can be effective on the rate of reaction.
A) only I B) only II C) I and IV
D) I, II and IV E) I, II, III and IV

10. Obtain three test tubes and fill 5 ml of hydrogen peroxide to each tube. Crush one of the pieces of liver with a mortar and pestle and add it to one of the test tubes and add the pieces of frozen liver to a second tube. Add natural pieces of liver to the third tube. It may be helpful to use a small spatula when transferring the liver to the tube. How do you put in order the tubes according to rate of reaction?
A) I, II, III B) II, I, III C) II, III, I
D) III, I, II E) III, II, I

11. Enzymes have:
I apo-enzyme, II coenzyme and III cofactors
Which of the above is inorganic?
A) only I B) only II C) only III
D) I and II E) II and III

12 A + B e C

Which of the following is required for above reaction**?**
A) water B) coenzyme C) cofactor

D) high temperature E) ATP

13. Which of the following is present at enzyme structure?
A)amino acids B)glucose C)nucleic acid D)nucleotide E)fatty acid

14 Many enzymes require the presence of an additional cofactor or coenzyme . Coenzymes may be covalently bound to the apo-enzyme part .
Which of the cofactor , coenzymes and apo-enzyme is always protein?
A) only I B) only II C) only III
D) I and II E) II and III

15 I each enzyme works within quite a small pH range
II Enzymes have active site
III Enzymes required usually vitamins or made from vitamins
IV Enzymes contains prosthetic groups such as metal ions.
Which of the above are always true?
A) only I B) only II C) I and II
D) II and III E) II, III IV

16. Which of the following is true about enzyme catalyzed reactions?

	activation energy	rate of reaction
A)	increase	decrease
B)	increase	increase
C)	decrease	decrease
D)	stable	increase
E)	decrease	increase

17. Which of the followings denaturates the enzymes by increasing?
I temperature
II pH
III enzyme concentration
IV substrate concentration
A) I and II B) I and III C) III and IV
D) I, II and III E) II, III and IV

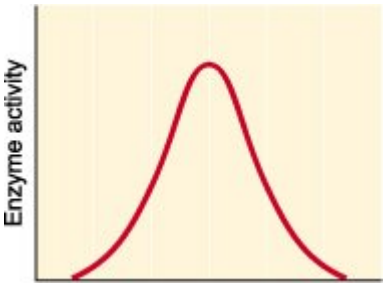
18. Obtain a test tube and put a amount starch and than add enzymes for hydrolysis reaction. Observations on the reaction Which of the following are excepted?
I starch concentration
II enzyme concentration
III glucose concentration
A) only I B) only II C) I and II
D) I and III E) II and III

19. Activation energy is,
A) energy that must be added to get a reaction started, which is recovered as the reaction proceeds
B) difference in energy between reactants and products
C) energy that is lost as heat
D) free energy
E) equal to the entropy times the absolute temperature

20 Which of the following is true why the activity of enzymes is strongly affected by changes in pH and temperature**?**
A) Most are proteins.
B) Enzymes are catalysts
C) Enzymes are contains cofactor
D) Enzymes are catalysts
E) Enzyme molecules are sensitive to inhibitors

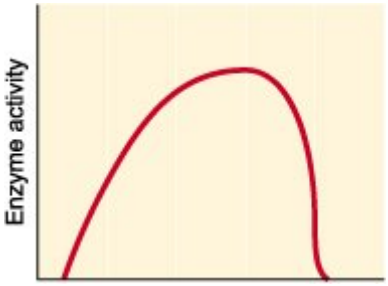
21. To overcome an energy barrier between reactants and products, energy must be provided to get the reaction started. This energy, which is recovered as the reaction proceeds, is called:
A) activation energy
B) initiation energy
C) reaction energy
D) kinetic energy
E) potential energy

22.



The diagram shows a typical relationship between enzyme activity and:
A) pH
B) enzyme concentration
C) substrate concentration
D) temperature
E) activation energy

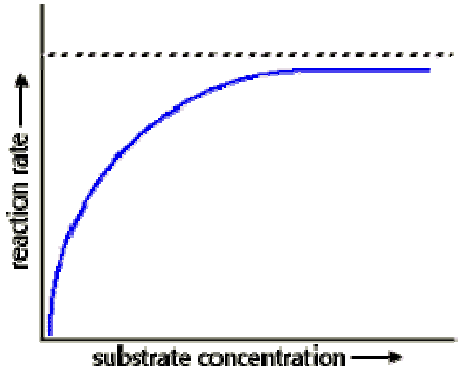
23.



The diagram shows a typical relationship between enzyme activity and:
A) enzyme concentration
B) substrate concentration
C) temperature
D) pH
E) inhibitors

24. Which of the following statements about reaction rate is NOT true?
A) Reaction rate is the speed at which the reaction proceeds toward equilibrium.
B) Reaction rate is governed by the energy barrier between reactions and products.
C) Enzymes can accelerate the rate of a reaction.
D) Reaction rates are not sensitive to temperature.
E) None of these.

25.



In the graph reaction rate vs substrate concentration, the reason that the curve reaches a plateau, and does not increase any further at high substrate concentration is that:

A) the active site is saturated with substrate
B) there is a competitive inhibitor present
C) there is a non-competitive inhibitor present
D) the allosteric enzyme is locked in an inactive conformation
E) all substrate has been converted to product