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Identifying and Comparing the Degree of Difficulties Biology Subjects By Adjusting It is Reasons in Elementary and Secondary Education

Taner Ozcan*, Sami Ozgur, Aybuke Kat, Sukran Elgun

Biology Education, Necatibey Faculty of Education, Balikesir University, 10100, Balikesir, TURKEY

Abstract

The purpose of this study was to determine elementary school eighth grade students' and secondary school 12th grade students' perceptions of having difficulties with respect to understanding Biology subjects, and whether they still had difficulties in this hardly learnt subjects when they came to high school after the elementary school. The results revealed that "Controller and Organizer Systems", a biology subject in elementary school and "Photosynthesis", a biology subject at secondary school in Turkey were more difficult to understand than other biology subjects for the participants in our study.

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1. Introduction

Recent developments in science and technology (especially in genetics, bio-technology, molecular biology etc.) have improved so much that they have changed our lives to a great extent. Developments in biology have particularly emphasized the significance of biology. Consequently, academic programs of the biology course are arranged in a way that will support the objective to train biology literate individuals who are aware of themselves and surroundings, and who know the nature of science and biology, and can analyze the problems they encounter. (Ministry of National Education) Regarding the main objective of the biology course, researches have been carried out that reveal the necessity of literate biology students. (Baran *et al.*, 2002; Tuan *et al.*, 2005).

Developed countries see biology training and learning as a cultural necessity, and they have conducted studies to improve the quality of biology training. These studies aimed to update science programs permanently, and to establish programs intended towards needs. (Hurd, 1998; Ayas, 1995). To conclude, science and biology have a great role in education (Baran *et al.*, 2002).

As well as the importance of science and biology in education, biology has a great role in our daily lives, too. Though we are so close to biology, it is a difficult course for many students (Steak, 1995; Yeşilyurt and Gül, 2008). When the effect of biology on our lives is considered, linking biology to tangible experiences will ensure effective and permanent learning. The students must be outside the traditional model, that is, they must be active. Laboratory studies will enable the students to be active. Furthermore, through such studies requiring activities (field studies,

* Corresponding Author Taner OZCAN. Tel.: +90 (266) 241 27 62
E-mail address: ozcant@balikesir.edu.tr

travel-observation etc.) students will learn the subject better, realize their mistakes, correct their errors about the concept, and enjoy the lesson more (Uzun and Sağlam, 2005; Uzun and Sağlam, 2003; Sinan and Karagöz, 2010). Latin concepts take place in course books. This causes learning difficulties. When these are replaced by Turkish ones, learning will be easy and permanent (Kete and Acar, 2007).

In previous studies, difficulties in learning biology were studied and the reasons were revealed (Lazarowitz *et. al.* 1992; Tekkaya *et. al.* 2000; Güneş and Güneş, 2005). It was seen that their success in biology course was affected by their attitudes towards biology. (Mutlu, 2006; Üredi and Üredi, 2005). The factors affecting attitudes towards biology were also investigated, and analyzed depending on factors such as gender, teacher, school administrators, school, class, location of the primary school the students graduated from and their general academic success etc. (Ekici and Hevedanlı, 2010; Prokop *et. al.*, 2007; Uitto *et. al.* 2006; Üredi and Üredi, 2005; Yeşilyurt and Gül, 2008).

The reasons for learning difficulties in biology subjects need to be identified through comprehensive studies, and recommendations should be presented. Thus, research depending on a specific variant may not give satisfactory results.

In our study, we aim to deal with the biology subjects in primary and secondary education in terms of learning difficulties, and to compare the learning difficulties in corresponding biology subjects in primary schools and secondary schools with their reasons.

2. Material and Method

2.1. Target Population and Sample

As for primary schools' target population, the study covers eighth grade students in the city centers of Bursa and Balıkesir, and their towns. As for secondary schools' target population, the study covers the 12th grade students in Balıkesir city.

As for primary schools' sample, the study covers one randomly chosen primary school in Balıkesir city centre, two randomly chosen primary schools in Balıkesir, Gönen town, and three randomly chosen primary schools in Bursa city centre. As for secondary schools' sample, the study covers four high schools in Balıkesir city.

2.2. Data Collection

In order to identify learning difficulties for the primary school second stagers and secondary school last grade students, grading scales were prepared by the conductors of this study. For this purpose, primary education program was studied; unit and subject titles were identified. In the scale ,there were 60 items, and two open-ended questions that aimed to identify the reasons of the degrees of difficulty. Concerning the secondary education, unit and subject titles found in 9th, 10th and 11th grade classes biology courses were identified. A survey covering the 26 items and two open-ended questions elected to be applied to 12th graders was prepared. In order to identify the biology subjects' degrees of difficulty, the primary school and secondary school students were asked to give 1-10 points to the items mentioned above. (1 for the easiest, and 10 for the most difficult).

2.3. Data Analysis

$$\text{Difficulty index} = N_k / N_t \times N_m$$

Nk: Total amount of the points given to subjects

Nt: Total number of students

Nm: Total number of subject titles

First Analysis:

To identify the biology subjects' degrees of difficulty in general, the scores of 200 students were summed and divided into the number of students X total number of subject titles. Learning difficulties depending on gender differences were analyzed using formulas below.

$$\text{Difficulty index} = \frac{\text{Total amount of the points given to subject titles by the females}}{\text{Number of females x number of subject titles}}$$

$$\text{Difficulty index} = \frac{\text{Total amount of the points given to subject titles by the males}}{\text{Number of males x number of subject titles}}$$

Second Analysis:

The schools were analyzed separately. The units of each school were summed separately; the total scores of subject titles were divided into the multiplication of the number of students and total number of subject titles. Biology difficulty degree of each school was found, and schools were compared in this way.

Third Analysis:

Analysis was based on units. Points of all units were summed, and divided into the number of students to find the difficulty degree of each unit.

$$\text{Difficulty index} = \frac{\text{Sum of points to any unit by students}}{\text{Number of students x number of subject titles for any unit}}$$

Fourth Analysis:

A Unit by unit analysis was carried out. The scores of all units were summed, and divided into the number of participants..

$$\text{Difficulty index} = \frac{\text{Sum of points to any unit by students}}{\text{Number of students x number of matters for any unit}}$$

Fifth Analysis:

Open-ended questions were analyzed in charts.

3. Findings

Findings obtained are given separately regarding primary education and secondary education.

3.1. Findings regarding Elementary Education

Table 1. Biology Subjects' Degrees of Difficulty in General and Depending on Gender

Biology Subjects' Degrees of Difficulty	
General	4.54
Females	4.03
Males	5.06

It is seen that females is under the general average and males learn more difficulty the biology concepts (Table 1).

Table 2. School analysis (Degrees of Difficulty regarding Primary Schools)

School Name	Degree of Difficulty
School 1	5.18
School 2	4.5
School 3	2.47
School 4	8.7
School 5	4.35
School 6	3.15

As shown in Table 2, Biology concepts are more difficult according to students in School 4.

Table 3. Unit analysis (Degrees of Difficulty depending on the Subjects)

Unit No	Unit Title	Degree of Difficulty
1	Let's Solve the Body Puzzle	6.8
2	Let's Travel Around and Learn About the World of Living Beings	2.60
3	Let's Solve the Body Puzzle	5.1
4	Let's Travel Around and Learn About the World of Living Beings	6.3
5	Reproduction, Growth and Development in Living Beings	4.5
6	Systems in Our Body	6.0
7	Human and the Environment	9.13
8	Cell Division and Heredity	7.5
9	Living Beings and Energy Relationships	4.5

Human and the Environment is the most difficult unit for learning. Moreover, Cell Division and Heredity, Let's Solve the Body Puzzle and Let's Travel Around and Learn about the World of Living Beings units are the other difficult units for learning.

Table 4. Subjects analysis (Subjects' Degrees of Difficulty)

Subjects	Degree of Difficulty
Support and Motion	7.14
Breath Taking – Giving	4.42
Circulation of Blood Throughout the Body	5.35
Let's Do Exercise	8.42
Let's Learn About the Things in Our Environment	3.57
The Environment We Live In	4.92
Nutrition and Balanced Diet	4.71
Food Digestion	7.07
Discharge of Harmful Materials	7.57

Harms of Smoking and Alcohol	2.37
Classification of Living Beings and the World of Living Beings	7.42
The Environment We Live In (Different Living Areas)	3.06
The Effects of Humans on the Environment	4.92
The Cell	9.14
Reproduction, Growth and Development in Humans	3.42
Reproduction, Growth and Development in Animals	4.14
Reproduction, Growth and Development in Plants	3.0
Circulation System	6.71
Respiratory System	7.78
Digestive System	3.5
Excretory System	5.57
Controller and Organizer Systems	9.31
Sense Organs	7.21
Ecosystems	8.71
Mitosis	8.07
Heredity	7.0
Meiosis	6.85
DNA and The Genetic Code	7.57
Adaptation and Evolution	5.35
Energy Flow in The Nutrition Band	5.14
Substance Cycles	8.42
Recycling	3.92
Renewable and Non-Renewable Energy Sources	4.14

The most difficult subjects is Controller and Organize Systems (9.31). And The Cell, Let's Do Exercise and Substance Cycles subjects are the other difficult subjects respectively (Table 4).

Table 5: The Reasons for Easy Learning

The Reasons for Easy Learning	Number of Students	Frequency
The subjects are easy.	51	25.5
I have studied the subject.	2	1
I have interest. I am curious.	34	17
I like biology course.	4	2
Our teacher taught the subject well. The instruction was clear and understandable.	16	8
Visual materials were used.	15	7.5
I can understand.	6	3
We made the researches given at the end of the subject.	1	0.5
The intangible concept was conceptualized.	2	1
I studied at home first. Then went to school and listened to the lesson.	9	4.5
I revised the subject after the teacher had told.	10	5
We performed activities.	3	1.5
The subject is related to the daily life.	18	9
The subjects are easy as they are oral.	6	3
We revised the subjects in class.	5	2.5
I was able to focus on the subject.	1	0.5
They were the subjects we had learned before.	8	4
I understood the last subjects.	2	1
We told the subject.	1	0.5
I solved tests after lesson. I did homework.	2	1
They don't require much knowledge.	1	0.5
I listened to lesson well.	3	1.5
The subjects are suitable for memorizing.	1	0.5
The subjects are interrelated.	1	0.5
Latin expressions helped me understand the subject better.	1	0.5

In Table 5 show the reasons why some subjects learn easier than the others. "The subjects are easy", "I have interest. I am curious" and "The subject is related to the daily life" are some of the reasons.

Table 6: The Reasons for Difficult Learning

	The Reasons for Difficult Learning	Number of Students	Frequency
Problems arising from the teacher	The teacher did not attend the lesson	1	0.5
	The teacher passed the subject quickly	2	1
	The teacher did not instructed well	11	5.5
Problems arising from the student	I do not study the subject before the lesson.	1	0.5
	I do not repeat the subject	9	4.5
	I do not listen to subject.	3	1,5
	I have no interest.	15	7.5
	I do not understand.	17	8.5
	I have not been in the lesson.	5	2.5
	I do not study.	1	0.5
	I didn't deal with the subjects in prior classes.	5	2.5
	I suppose to understand but i am confusing.	2	1
Problems arising from the subject	The subject requires knowing a lot of information.	3	1.5
	The subject is too complicated, detailed, difficult.	44	22
	Mathematical subjects are very difficult.	3	1.5
	The subject requires memorizing.	5	2.5
	The subjects are difficult as they are new.	1	0.5
Problem arising the other reasons	No visual materials were used.	2	1
	No connection to daily life was made.	1	0.5
	We didn't do any experiments.	2	1

Students learn some subjects difficultly; it is shown that the reasons why some subjects are not learned easily. And it is seen from table 6, problems arising from the subject are very important.

3.2. Findings regarding Secondary Education

Table 7: Biology Subjects' Degrees of Difficulty in General and Depending on Gender

Biology Subjects' Degrees of Difficulty	
General	4.44
Females	3.98
Males	4.81

It is seen that females is under the general average and males learn more difficulty the biology concepts (Table 7).

Table 8: Degrees of Difficulty regarding Secondary Schools

School Name	Degree of Difficulty
School 1	4.29
School 2	5.22
School 3	4.65
School 4	3.87

It is shown from Table 8, Biology concepts are more difficult according to students in school 2.

Table 9: Degrees of Difficulty Depending on the Subject

Unit	Degree of Difficulty
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9 th Grade	1	The Cell, Organism and Metabolism	3.91
	2	Classification of Living Beings and Biological Variety	6.25
	3	Conscious Human-A Liveable Environment	2.10
10 th Grade	4	Energy Transformation in Living Beings	9.5
	5	Cell Division and Reproduction	6.54
	6	Ecosystem Ecology	3.96
11 th Grade	7	Plants Biology	4.63
	8	Heredity, Genetic Engineering and Bio-Technology	6.75
	9	Community and Population Ecology	5.75

Energy Transformation in Living Beings is the most difficult unit for learning. And Heredity, Genetic Engineering and Bio-Technology, Cell Division and Reproduction and Classification of Living Beings and Biological Variety units are the other difficult units for learning.

Table 10: Subjects' Degrees of Difficulty

	Subjects	Degree of Difficulty	
9 th Grade	1	The Cell	2.88
	2	Comparison of Cells and Nuclear Organization	3.68
	3	Classification of Living Beings	7.12
	4	The World of Living Beings	7.4
	5	Biological Variety and Preservation of Species	3.36
	6	Environmental Problems	2.20
	7	Atatürk's Views on Nature and Environment	2.16
10 th Grade	8	Respiration in Living Beings: Energy Release	9.40
	9	Photosynthesis: Energy Bonding	9.68
	10	Chemosynthesis	8.72
	11	Mitosis and Asexual Reproduction	5.28
	12	Meiosis and Sexual Reproduction	6.24
	13	The Structure and Significance of the Ecosystem	3.72
	14	Energy Flow and Substance Cycles in the Ecosystem	5.64
11 th Grade	15	Structure of Plants	3.8
	16	Transmission in Plants	3.8
	17	Nutrition, Growth and Motion in Plants	3.08
	18	Sexual Reproduction in Plants	3.8
	19	Germination in Plants	4.48
	20	Mendel Genetics	6.36
	21	Modern Genetics	6.48
	22	The Structure and Replication of DNA	5.88
	23	Bio-technology and Genetic Engineering	7.36
	24	Community Ecology	4.32
	25	Population Ecology	4.88
	26	Biomes	5.84

According to students, photosynthesis is the most difficult subject which is in energy transformation in living beings unit. In addition, the second difficult subject is respiration in living beings: energy release (Table 10). Because of these subjects are too complicated and microscopic events, students do not easily learn those subjects.

Table 11: The Reasons for Easy Learning

	Number of Students	Frequency (%)
They are related to the daily life	50	21.2
They include little information, they don't depend on memorizing, they are interpretable	45	19.1
I like the subjects	10	4.2

The reasons for easy learning	I learnt easily because I studied and revised the subjects	12	5.1
	I find them enjoyable and interesting	50	21.2
	The teacher told the subject well	15	6.3
	The subjects are visually rich (tangible)	13	5.5
	The subjects are revised again and again since primary education	18	7.6
	I like biology	8	3.4

Table 12: The Reasons for Difficult Learning

	Number of Students	Frequency (%)	
The reasons for difficult learning	Inter-conceptual relationships cannot be formed.	10	4.2
	Connection to daily life is difficult.	12	5.1
	It covers foreign (Latin) concepts.	15	6.3
	It depends on memorizing	60	25.5
	No visual materials are formed (intangible concepts cannot be made tangible)	11	4.6
	The subject is long, complicated and includes too many details	85	36.1
	The subject is not interesting (the student is not interests in the subject)	25	10.6
	I did not study	10	4.2
	Classroom context is insufficient.	2	0.8
	The subject is not suitable for the development level of the student	5	2.1

Why are some subjects learnt easily or difficulty? The answer of this question is given in Table 11 and Table 12. If subjects are enjoyable or interesting or related to daily life, they are learnt easily. On the other and, if the subjects are long, complicated, includes many details, and depend on memorizing, these subjects are learnt difficulty.

Table 13: Degrees of Comparison of the Common Subjects in Primary and Secondary Education

	Primary Education	Secondary Education
The Cell	9.14	2.88
Classification of the Living Beings	7.42	7.12
Environmental Problems	4.92	2.20
Mitosis and Asexual Reproduction	8.07	5.28
Meiosis and Sexual Reproduction	6.85	6.24
Ecosystems	8.71	3.72
Substance Cycles	8.42	5.64
Nutrition, growth and motion in plants	3.0	3.08
Mendel Genetics	7.0	6.36
DNA's structure and the genetic code	7.57	5.88

When corresponding subjects in primary and secondary education are compared, it is seen that learning difficulties of some subjects deals with in primary education such as the classification of living beings, mitosis and meiosis, substance cycles, Mendel genetics, DNA's structure and the genetic code, continued in secondary education, too (Table 13).

4. Conclusions and Recommendations

Biology subjects' degrees of difficulty in general are 4.54 in primary education, and 4.44 in secondary education. In education, degree of difficulty for the females is above the general average with 4.03. In secondary education, the value is 3.98. As for the males, degree of difficulty is below the overall average. It is 5.06 in (primary education)

and 4.81 in secondary education. According to these results, it is observed that biology subjects are generally learned more difficultly in primary and secondary education (Table 6 and Table 7). Males were found to have more difficulty while females learned more easily as they studied more and had more interest in biology course.

Regarding the primary education, the participants have difficulty in learning are support and motion, let's do exercise, discharge of harmful substances, classification of living beings and the world of living beings, the cell, circulation system, respiratory system, controller and organizer system, sense organs, ecosystems, mitosis, heredity, meiosis, DNA and the genetic code, substance cycles (Table 4). Main reasons for difficult learning of these subjects: There are 56 students (28%) blaming the problems arising from the subject (subjects are too complicated, detailed, difficult, mathematical and require memorizing); 44 students (22%) blaming the problems arising from themselves (I didn't attend the lesson, I didn't study, I couldn't understand); 14 students (7%) blaming the problems arising from the teacher (The teacher didn't attend the lesson, didn't instruct well, passed the subject quickly); and 18 students (9%) telling that they have no interest in biology course. A small portion of the group added that no visual materials were used; no experiments were made; the subjects were not related to daily life, and the subjects were new to them.

Regarding the secondary education, the subjects students have difficulty in learning are classification of living beings, the world of living beings, respiration in living beings, photo-synthesis, chemo-synthesis, mitosis and asexual reproduction, meiosis and sexual reproduction, energy flow and substance cycles in ecosystem, Mendel genetics, modern genetics, DNA's structure and replication, bio-technology and genetic engineering, biomes (Table 10). Reasons for difficult learning of these subjects: There are 10 students (4.2%) stating that no inter-conceptual relations were formed; 12 students (5.1%) stating that the subjects were not related to daily life; 15 students (6.3%) stating that there were Latin expressions; 60 students (25.5%) stating that the subjects required memorizing; 11 students (4.6%) stating that no visual materials were used; 85 students (36.1%) stating that the subjects were too long and detailed; 25 students (10.6%) stating that they had no interest in the subject.

When subjects are learnt with difficulty in primary school, they are also learnt with difficulty in high school, and meaningful learning of the new information is made more difficult. Environmental problems, the cell and ecosystems subjects were found to be learnt more easily in secondary education compared to primary education. The reasons for this are that students' readiness is higher in secondary education, and that the subjects are easy and understandable (Table 13).

According to Ausebel's learning principle, new concepts, information and principles should be related to previous knowledge. Generalization should be made, and knowledge should be structured in mind through piling up the knowledge. Otherwise learning cannot be meaningful and permanent (Ergün and Özdaş, 1997).

Güneş *et. al.* (2005) found that, the genetics and cell division subjects are learnt difficultly and caused learning difficulties in further stages, as well. In our study, we revealed that, subjects in secondary education were learnt easily once they were related to the less comprehensive subjects of the primary education in a particular hierarchy and order.

The cell division is a microscopic subject. Unless the expressions seen in this subject (titrate, chromosome, chromatid) are related to daily life, the subject is learnt more difficultly (Taşçı and Soran, 2008). In our study, we found that the use of materials and relation of the subject to the daily life could foster the learning of the subject. Moreover, giving information the students might benefit from in their lives increases the level of interest in the course.

Maraş and Akman (2009) revealed in their study that the use of laboratory and a computer aided instruction fostered learning more than the traditional education method. Sinan and Karadeniz (2010) concluded at the end of the activity studies they conducted that students were able to see their mistakes about the subject during the activity, and they both learned correctly and enjoyed themselves. In our study, we detected that the subjects were based on

memorizing and hindered learning. Activities should be arranged to prevent this, and education should be released from the traditional method. Lastly, subjects should be made interesting. Forming a bond among the complicated and long subjects through mind maps can also help the students learn the subjects more easily.

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