

A COMPARATIVE ANALYSIS OF ECOLOGY UNITS IN THE BIOLOGY
TEXTBOOKS OF SECONDARY SCHOOL PROGRAMS

A MASTER'S THESIS

BY

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THE PROGRAM OF CURRICULUM AND INSTRUCTION
BILKENT UNIVERSITY
ANKARA

JULY 2013

To my dear mother, father and sister

A COMPARATIVE ANALYSIS OF ECOLOGY UNITS IN THE BIOLOGY
TEXTBOOKS OF SECONDARY SCHOOL PROGRAMS

The Graduate School of Education

of

Bilkent University

by

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In Partial Fulfilment of the Requirements for the Degree of

Master of Arts

in

The Program of Curriculum and Instruction

Bilkent University

Ankara

July 2013

BILKENT UNIVERSITY
GRADUATE SCHOOL OF EDUCATION
A COMPARATIVE ANALYSIS OF ECOLOGY UNITS IN THE BIOLOGY
TEXTBOOKS OF SECONDARY SCHOOL PROGRAMS

Supervisee: Sinem Ödün

July 2013

I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Arts in Curriculum and Instruction.

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ABSTRACT

A COMPARATIVE ANALYSIS OF ECOLOGY UNITS IN THE BIOLOGY TEXTBOOKS OF SECONDARY SCHOOL PROGRAMS

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July 2013

The purpose of this study was analyze and compare ecology units in four Ministry of National Education (Milli Eğitim Bakanlığı, MEB) biology textbooks, International Baccalaureate Diploma Programme (IBDP) biology textbook and International General Certificate of Secondary Education (IGCSE) biology textbook in terms of content, presentation and learning. Content analysis was used as a research method and interviews were conducted with biology teachers.

The analysis of the ecology-related unit content of textbooks showed that MEB textbooks cover large numbers of life connections and interdisciplinary treatments which makes MEB textbooks advantageous over the other two textbooks.

From the perspective of presentation, the IGCSE textbook is the only textbook that has teachers' resource kit. The other advantageous point is presenting bite-size information, a chunking. The IBDP textbook contains lots of links to a website that makes textbook interact with technology.

Regarding learning, the ecology units of MEB textbooks rank higher hierarchy than IBDP and IGCSE textbooks. MEB textbooks present the most friendly language style. Moreover, MEB textbooks support students with activities and, variety of questions.

Key words: Content analysis, biology textbooks, biology curriculum, Ministry of National Education, International Baccalaureate Diploma Programme, International General Certificate of Secondary Education

ÖZET

ORTAÖĞRETİM PROGRAMLARININ BİYOLOJİ DERS KİTAPLARINDA EKOLOJİ ÜNİTELERİNİN KARŞILAŞTIRMALI BİR ANALİZİ

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Temmuz 2013

Bu çalışmanın amacı, Milli Eğitim Bakanlığı (MEB), Uluslararası Bakalorya Diploma Programı (UBDP) ve Uluslararası Genel Ortaöğretim Sertifikası'nın biyoloji kitaplarına bulunan ekoloji ünitelerinin içerik, sunum ve öğrenim açılarından incelenmesi ve karşılaştırılmasıdır. İçerik analizi araştırma yöntemi olarak kullanılmış olup, biyoloji öğretmenleri ile mülakatlar yapılmıştır.

Ekoloji ünitelerinin içerik incelenmesi göstermiştir ki MEB biyoloji ders kitapları içerdiği yüksek sayıda yaşam bağlantıları ve disiplinler arası uygulamalar ile diğer iki ders kitabına göre daha avantajlı durumdadır.

Sunum yönünden, Uluslararası Genel Ortaöğretim Sertifikası ders kitabı, incelenen kaynaklar arasında, öğretmen kaynağı sunan tek kitaptır. Bir diğer avantajlı nokta ise bilgilerin kısa kısa sunulmasıdır. UBDP ders kitabı içerdiği web sitesi bağlantılarıyla teknoloji bakımından diğerlerine göre daha iyi durumdadır.

Öğrenim açısından, MEB ders kitapları ekoloji üniteleri UBDP ve Uluslararası Genel Ortaöğretim Sertifikası ders kitapları arasında ön plana çıkmaktadır. MEB ders kitabı en arkadaşçı anlatıma sahip kitaptır. MEB ders kitapları aktiviteler ve yüksek çeşitlilikteki soru tipleri ile öğrencileri desteklemektedir.

Anahtar Kelimeler: İçerik analizi, biyoloji ders kitapları, biyoloji müfredatı, Milli Eğitim Bakanlığı, Uluslararası Bakalorya Diploma Programı ve Uluslararası Genel Ortaöğretim Sertifikası

ACKNOWLEDGEMENTS

I would like to express my deepest appreciation to my supervisor, Prof. Dr. Alipaşa Ayas for his encouragement, support and guidance throughout this study. He always answered my endless questions and I thank him for his patience until the end.

I would like to express my deepest thanks to Prof. Dr. M. K. Sands and Dr. Jennie Farber Lane for the time they spent reading and correcting my thesis.

I would like to express my thanks to Prof. Dr. Abdullah Demirtaş and Dr. Emily Wilson for their feedback and constructivist suggestions.

I wish to acknowledge members of Graduate School of Education for their support and help throughout this study. I'm also grateful to İhsan Doğramacı Bilkent University for the scholarship provided throughout my MA program.

I would like to thank the biology teachers who attended interviews for this study and shared their ideas regarding the textbooks.

I wish to express my thanks to my friends for their help and support until the end.

Finally, I would like to express my love to my parents for encouraging me in difficult times and for all the emotional support they have provided throughout my life.

TABLE OF CONTENTS

ABSTRACT.....	iii
ÖZET.....	iv
ACKNOWLEDGEMENTS	v
TABLE OF CONTENTS.....	vi
LIST OF TABLES	xi
LIST OF FIGURES	xiii
CHAPTER 1: INTRODUCTION	1
Introduction	1
Background	1
Problem	3
Purpose	4
Research questions	4
Significance	5
Definition of key terms.....	6
CHAPTER 2: REVIEW OF RELATED LITERATURE.....	8
Introduction	8
The features and analysis of textbooks.....	8
Importance of textbooks	8
Characteristics of textbooks.....	9

Textbook analysis studies	11
The coverage of ecology units in biology curricula	15
The importance of ecology	15
The context of ecology unit in MEB, IBDP and IGCSE curricula	17
Ministry of National Education and biology	17
International Baccalaureate Diploma Programme and biology	18
International General Certificate of Secondary Education and Biology	22
Conclusion.....	23
CHAPTER 3: METHOD	24
Introduction	24
Research design.....	25
Context	26
Instrumentation.....	28
Method of data collection and analysis	28
Content.....	29
Presentation.....	31
Learning	34
CHAPTER 4: RESULTS	38
Introduction	38
Content	38
Alignment with curriculum requirements.....	38
Level of treatment.....	49

Expertise for content development	52
Accuracy of content	52
Currentness of content	54
Authenticity of content	55
Multicultural representation.....	58
Humanity and compassion.....	58
Presentation	58
Comprehensiveness of students and teacher resources.....	59
Alignment of instructional components.....	59
Organization of instructional materials.....	60
Logical organization	66
Readability of instructional materials	69
Pacing of content	70
Ease of materials use.....	70
Learning.....	71
Motivational strategies.....	72
Teaching a few “Big Ideas”	74
Explicit instruction.....	75
Guidance and support	76
Active participation of students	78
Targeted instructional and assessment strategies.....	79
Instructional strategies and assessment technique	81

Interviews with MEB, IBDP and IGCSE biology teachers.....	82
Alignment with curriculum requirements.....	83
Level of treatment.....	83
Expertise for content development.....	83
Accuracy of content.....	84
Currentness of content.....	84
Authenticity of content.....	85
Multicultural representation.....	86
Humanity and compassion.....	86
Comprehensiveness of student and teacher resources.....	86
Logical organization.....	86
Readability of instructional materials.....	87
Ease of materials use.....	87
Pacing of content.....	88
Motivational strategies.....	88
Teaching a few “big ideas”.....	89
Explicit instruction.....	89
Guidance and support.....	89
Targeted instructional and assessment strategies.....	90
CHAPTER 5: DISCUSSION.....	91
Introduction.....	91
Discussion of the findings.....	92

Content.....	92
Presentation.....	98
Learning.....	103
Conclusion.....	108
Implications for practice.....	109
Implications for further research	110
Limitations.....	111
REFERENCES.....	112
APPENDICES	122
APPENDIX A: Paragraphs from the MEB textbooks	122
APPENDIX B: Paragraphs from the IBDP textbook.....	128
APPENDIX C: Paragraphs from the IGCSE textbook	131
APPENDIX D: Readability levels and readability results of the six selected textbooks	132
APPENDIX E: Interview questions	134

LIST OF TABLES

Table	Page
1 Textbooks analyzed in this study	27
2 Headings and sub-headings of criteria used in textbook analysis.....	29
3 Topics in ecologyrelated units of the MEB curriculum.....	42
4 Ecology topics in the IBDP curriculum	42
5 Ecology topics in the IGCSE curriculum.....	43
6 MEB objectives of ecology topics	45
7 IBDP objectives for Topic 5	46
8 IBDP objectives for Option G	46
9 IGCSE objectives for Section 4	47
10 Amount of time for ecology topics in MEB curriculum, per grade	51
11 Amount of time for ecology topics in IBDP curriculum, Topic 5	51
12 Amount of time for ecology topics in IBDP curriculum, Option G.....	52
13 Latin names in the selected textbooks.....	53
14 Numbers of life connections in the MEB, IBDP and IGCSE textbooks.....	56
15 Some features for access to content of the MEB, IBDP and IGCSE textbooks	60
16 Weight of the ecology topics in the six biology textbooks	64
17 Visual structure of the six textbooks.....	65
18 Boxes of the MEB textbooks	65
19 Boxes of the IBDP textbook	66
20 Order of ecology-related units in MEB textbook by sub-heading	66
21 Order of Topic 5 in IBDP textbook by sub-heading.....	67
22 Order of Option G in IBDP textbook by sub-heading	67

23	Order of ecology topics in IGCSE textbook by sub-heading.....	68
24	Classified visuals of the six textbooks	70
25	Comparison of big ideas of the textbooks.....	74
26	Number of analogies of six textbooks.....	77
27	Lists of activities that are offered in the MEB textbooks	78
28	Teachers’ opinions regarding level of treatment.....	83
29	Teachers’ opinions regarding accuracy of content.....	84
30	Teachers’ opinions regarding currentness of content.....	85
31	Teachers’ opinions regarding authenticity of content.....	85
32	Teachers’ opinions regarding logical organization	86
33	Teachers’ opinions regarding readability of instructional materials.....	87
34	Teachers’ opinions regarding ease of materials use.....	88
35	Teachers’ opinions regarding pacing of content	88
36	Teachers’ opinions regarding motivational strategies.....	89
37	Teachers’ opinions regarding teaching a few “big ideas”	89
38	Teachers’ opinions regarding explicit instruction.....	89
39	Teachers’ opinions regarding guidance and support.....	90
40	Teachers’ opinions regarding targeted instructional and assessment strategies	90

LIST OF FIGURES

Figure	Page
1 (a) Disproportion problem in grade 10 MEB textbook (b) Better representation of organisms in the IGCSE textbook	54
2 MEB textbook grade 11 table of contents.....	61
3 Color code of questions for the IGCSE textbook	62
4 Examples of boxes from grade 11 MEB textbook.....	62
5 Information boxes of the IBDP textbook.....	63
6 Examples of chunking from the IGCSE textbook.....	64
7 MEB objectives according to Bloom's Taxonomy levels.....	80
8 IBDP objectives according to Bloom's Taxonomy levels	80
9 IGCSE objectives according to Bloom's Taxonomy levels.....	81
10 Types of questions in all textbooks.....	82

CHAPTER 1: INTRODUCTION

Introduction

Textbooks have a large effect on teaching and instruction in the classroom. Teachers use textbooks as a main source of instruction at all levels of education. Content, presentation, and the learning provided to students by textbooks are important for teachers for the effective delivery of the curriculum. Research studies related to textbook analysis have an importance for educators and teachers in determining the quality of textbooks. In particular, ecology topics are important for teachers in making students aware of environmental issues. Therefore, a study on textbook analysis, particularly regarding ecology topics, will provide useful information for biology teachers.

In this study, the Ministry of National Education (MEB) biology textbooks for grades 9, 10, 11 and 12 were analyzed and compared with one of the International Baccalaureate Diploma Programme (IBDP) biology textbooks and one of the International General Certificate of Secondary Education (IGCSE) biology textbooks.

Background

Textbooks play a large role in biology teaching, and the quality of textbooks affect the delivery of the curriculum. Therefore, textbook analysis studies have started to play an important role in education. There are a number of textbook analysis studies in mathematics, chemistry, physics and biology (Gökdere & Keleş, 2004). More

specifically, in the area of biology, many analysis studies have been conducted on textbooks. For example, primary school science textbooks were analyzed according to general, physical, educational, visual, representational and language features (Aycan, Kaynar, Türkoğuz & Arı, 2002). In another study, biology units of textbooks were analyzed according to content, visual components, language, spelling, preparation and evaluation activities (Atıcı, Samancı & Özel, 2007).

In another study, cellular respiration and photosynthesis chapters in MEB and IBDP biology textbooks were analyzed and compared with regard to content, presentation and learning strategies (İnanç Gök, 2012).

Çobanoğlu, Şahin and Karakaya (2009) focused on subject matter content, visual materials, question types, measurement-assessment techniques, design of activity and learning approach of 10th grade biology textbook. In addition, Özay and Hasenekoğlu (2007) conducted a study and investigated the visual presentation of 11th grade biology textbook. In another study, Özay and Hasenekoğlu (2006) analyzed reproduction, growth and development topics of biology textbook in terms of scientific content.

According to the literature, visual presentation, content and the language of textbooks are important considerations in textbook analysis studies (Aycan, Kaynar, Türkoğuz & Arı, 2002; Atıcı, Samancı & Özel, 2007; İnanç Gök, 2012; Çobanoğlu, Şahin & Karakaya, 2009; Özay & Hasenekoğlu; 2007; Özay & Hasenekoğlu, 2006).

IBDP and IGCSE are the international educational programs that are implemented all around the world including Turkey (IBO, 2013; Cambridge International Examinations (CIE), 2013). In the literature, there is no comparative study regarding

biology textbooks published by the MEB, textbooks that are used to deliver the IBDP curriculum and the IGCSE curriculum.

İnanç Gök (2012) compared cellular respiration and photosynthesis chapters of biology textbooks which are used to deliver the IBDP and the MEB curricula.

In particular, there was no comparative analysis study in the literature regarding ecology topics of biology textbooks. This study focuses on a comparison of content, presentation and learning of textbooks in terms of ecology units in MEB, IBDP and IGCSE curricula.

Problem

In Turkey, textbooks determine teaching and instruction in the classrooms, and teachers use textbooks as a main source of instruction. Qualified textbooks support effective teaching of biology topics. Therefore teaching objectives, design of the textbook, visual aids, content and learning provided for students are particularly important for teachers to deliver the curriculum. Many biology and science textbook analysis studies have been conducted in Turkey (Aycan, Kaynar, Türkoğuz & Arı, 2002; Atıcı, Samancı & Özel, 2007; Yapıcı, Coşkun & Akbayın, 2009; Çobanoğlu, Şahin & Karakaya, 2009). However, textbook comparison studies are not widely available in the literature. Moreover, some studies have shown that textbooks may cause some misconceptions; instruction from textbook can be insufficient in terms of scientific content and visual aids can be inappropriate for content (Özay and Hasenekoğlu, 2007; Özay and Heseneklioğlu, 2006; Kavşut, 2010). Biology textbook analysis studies have a great importance for biology teachers. Therefore, there is a need to investigate textbooks or at least units of textbooks to discover

content, presentation, and learning opportunities provided by the textbooks. The problem here is to analyze and compare ecology-related units in different textbooks that are used in the delivery of MEB, IBDP and IGCSE curricula. In addition, obtaining the views of biology teachers regarding ecology units of textbooks is a central part of the problem of this study.

Purpose

The aim of this study is to analyze and to compare ecology topics in terms of content, presentation and learning within the textbooks that deliver MEB, IBDP and IGCSE curricula. This study is planned as a qualitative research study. Content analysis method is used to analyze the textbooks. As a result of the analysis, similarities and differences of the textbooks are defined. This information will help biology teachers regarding the effective teaching of ecology topics. To provide supportive evidence biology teachers' views about textbooks are presented through face-to-face interviews and Skype-facilitated interviews. Opinions of teachers are the second part of this study.

Research questions

This study addresses the following research questions:

Main research questions:

- 1) Which biology textbook has the best coverage of ecology units within MEB, IBDP and IGCSE curricula, when evaluated according to FLDOE evaluation criteria?

Sub-questions:

- How do biology textbooks cover ecology-related topics in MEB, IBDP and IGCSE in terms of content (alignment with curriculum requirements, level of treatment, expertise for content development, accuracy of content, currentness of content, authenticity of content, multicultural representation, humanity and compassion)?
 - How do biology textbooks cover ecology-related topics in MEB, IBDP and IGCSE in terms of presentation (comprehensiveness of student and teacher resources, alignment of instructional components, organization of instructional materials, logical organization, readability of instructional materials, pacing of content, and ease of materials use)?
 - How do biology textbooks cover ecology-related topics in MEB and IBDP in terms of learning (motivational strategies, teaching a few “Big Ideas”, explicit instruction, guidance and support, active participation of students, targeted instructional assessment strategies, instructional strategies and assessment techniques)?
- 2) What are the opinions of biology teachers who use MEB, IBDP and IGCSE textbooks as a source of instructional material about content, presentation and learning of these textbooks?

Significance

It is common to use textbooks in biology teaching. Biology textbook analysis studies are often found in national published research literature (Çobanoğlu, Şahin & Karakaya, 2009). This study is significant for two reasons. Firstly, textbook studies have a specific importance since textbooks are used as the main source of instruction

at all levels of education. This study shows the differences and similarities based on an analysis of ecology topics of the textbooks. Moreover, information obtained from textbook analysis helps biology teachers with the effective teaching of ecology topics. Secondly, at the schools that implement both MEB and IBDP curricula and MEB and IGCSE curricula, biology teachers follow two different textbooks.

Therefore, collecting data and evidence on the opinions of biology teachers may help for better handling of biology teaching at IB high schools and high schools in Turkey where the IGCSE curriculum is delivered. Teachers' opinions were collected through interviews. During interviews, the answers of interviewees were noted down with their permission. This study also provides useful information for professionals in biology education.

Definition of key terms

Readability of textbook: According to Ateşman (1997), the readability is about whether a text is easy or difficult for the reader to understand. This definition focuses on relationship between readers and texts. Readability is about the difficulties of texts and appropriateness of texts to readers' age (Güyer, Temur & Solmaz, 2009).

According to the evaluation criteria for instructional materials of the Florida Department of Education (FLDOE) (2008), readability of instructional materials depends on (a) language style, (b) typographical presentation features, and (c) visual features.

Motivational Strategies: According to the instructional materials evaluation criteria by FLDOE (2008), textbooks as an instructional material must include positive

expectations, feedback and appearance. These features provide stability for students' motivation.

Explicit Instructions: According to the evaluation criteria for instructional materials of the FLDOE (2008), instructional materials must contain clear statements of information and outcomes. Therefore, clarity of explanations, and exclusion of ambiguity creates explicit instructions.

Life connection: Instructional materials should include real-life situations to make the content meaningful (FLDOE, 2008).

International Baccalaureate Diploma Programme (IBDP): International Baccalaureate is non-profit educational foundation which was founded in 1968. IBDP is an educational programme for students ages 16 thru 19 which prepares students for success at university and life (IBO, 2013).

International General Certificate of Secondary Education (IGCSE): IGCSE is the most popular international curriculum for students aged 14 thru 16. IGCSE prepares students for their next steps in education (CIE, 2013).

CHAPTER 2: REVIEW OF RELATED LITERATURE

Introduction

The aim of this study is to analyze and compare ecology-related units in textbooks that are used to deliver Ministry of National Education (MEB), International Baccalaureate Diploma Programme (IBDP) and International General Certificate of Secondary Education (IGCSE) curricula.

In this chapter, the importance and characteristics of textbooks will be explained by reference to the literature and textbook analysis studies will be discussed. Moreover, the coverage of ecology units in the literature, with regard to the MEB, the IBDP and the IGCSE curricula will be discussed.

The features and analysis of textbooks

Importance of textbooks

Yarger and Mintz (1980) indicated that students involved in learning activities spent 80% to 90% of their time in a typical school day interacting with instructional materials.

Textbooks are important sources that help students to receive related information about the topics stated in the curriculum. Moreover, textbooks are useful and economic source that they provide an opportunity for students to study and review as needed to prepare themselves for exams as well as to enhance their learning (Aycan, Kaynar, Türkoğuz & Arı, 2002). According to Rottensteiner (2010), textbooks serve

for planning, initiation, support and assessment. Moreover, textbooks can also be responsible for the quality of lessons because, in many cases, they are the most used source of information.

Textbooks are one of the essential parts of school curriculum. Textbooks are the best and fundamental source of communication between students and the curriculum.

Teachers make use of textbooks to support their teaching and textbooks also help teachers to teach more systematically. They are one of the most important teaching materials used to deliver the curriculum (Aycan, Kaynar, Türkoğuz & Arı, 2002).

According to Cemaloğlu (as cited in Korkmaz, 2008) textbooks help teachers to refresh their own knowledge as well as support teachers' self-confidence. Textbooks guide teachers, help them to teach more systematically and make lessons more effective with questions, diagrams and chapters. Moreover, textbooks provide good management of time. In addition, textbooks help students to gain lifelong skills, inform students in different areas, and are models for students in terms of information they serve. Textbooks improve thinking skills of students and provide opportunity to learn individually. Moreover, textbooks help students to remember information and direct them to further research.

Characteristics of textbooks

In biology education, textbooks are one of the most used teaching materials.

Teachers and students are strongly dependent upon textbooks in the learning process (Baran, 2006). Effective science textbooks should provide opportunities for students to learn and should strengthen interaction with students. In addition, they should help students to improve their critical thinking skills and problem solving skills. Science

is about nature and is strongly related with life, so science textbooks should direct students to observation rather than serving written information (Aycan, Kaynar, Türkoğuz & Arı, 2002).

According to Florida Department of Education (FLDOE) (2008, p. 11), teaching materials include some of the following features. These are stated as:

- instructional goals with adaptability to course requirements
- accurate, relevant, and relatively up-to-date information
- well-organized, coherent, and unified flow of information
- appropriate reading level and vocabulary
- effective layout, visual presentation, and physical features
- absence of stereotypes and biases
- multidisciplinary content with multiple rather than single perspectives
- small concepts taught as variations on larger themes
- development of insight and thinking skills rather than just memorization of isolated or unrelated facts
- real-world applications of informational skills
- inclusion of supplemental and reference materials for teaching

According to Kaptan (as cited in Ünsal & Güneş, 2002) one major aim in the preparation of textbooks is to include learning activities along with knowledge and skills. In addition, textbooks should lead these activities to achieve teaching objectives. At the beginning of the unit, textbooks should attract students' interests. During the unit, textbooks should provide opportunities for students to achieve objectives and, at the end of the unit; textbooks should enhance learning with observations, experiments as well as further research activities.

MEB (2012a) indicate that textbooks should be prepared as a suitable form to scientific literacy. Moreover, textbooks should be age appropriate and at the knowledge level of targeted students. Textbooks should contain appropriate visual materials to social community and should not contain any scientific errors.

Textbook analysis studies

In recent years, in the area of education, textbook investigation studies have started to play an important role. There are many research studies in the area of mathematics, chemistry and physics and as result of these studies evaluation criteria were established (Gökdere & Keleş, 2004).

Aycan, Kaynar, Türkoğuz and Arı (2002) investigated elementary school science textbooks. Sixth, 7th and 8th grade science textbooks were analyzed according to general, physical, educational, visual, representational, language features and experiments of textbooks. At the end of this study, researchers identified mistakes in the textbook. Researchers aimed to improve success in science education by encouraging well-written textbooks.

In another research study Atıcı, Samancı and Özel (2007) analyzed biology units of 6th, 7th and 8th grades science textbooks prepared by the MEB in terms of content, visual components, language and preparation and evaluation activities. In this study, 136 pre-service teachers analyzed the biology units of different textbooks and 32 in-service teachers answered a questionnaire prepared by the investigators. As a result, researchers stated that both pre-service teachers and in-service teachers were not satisfied with the assessment strategies and scientific content of the textbooks. On the other hand, the textbooks were effective for appropriateness of language and sentence structure. Moreover, the textbooks directed students to research and provided for the active participation of students.

Yapıcı, Coşkun and Akbayın (2009) analyzed the 10th grade biology textbook prepared by the MEB, published in 2006, for scientific content, visual presentation,

deficiency of information, language and readability method. The data were collected from the Field Textbook Review course reports of students. At the end of the study, researchers concluded that this textbook was generally adequate but some problems were found in concepts and visuals.

Çobanoğlu, Şahin and Karakaya (2009) conducted another textbook analysis study. They analyzed 10th grade biology textbooks prepared by the MEB. This research was based on qualitative research techniques and was divided into two stages. The first stage of the study was a document analysis of the 10th grade biology textbook. In this stage, researchers focused on subject matter content, visual materials, question types, measurement-assessment techniques, design of activities, and the learning approach. Moreover, the researchers examined textbooks using the criteria that were prepared by the National Research Council (NRC) and included an evaluation part. In the second stage of this research, pre-service teachers' opinions about learning approach of textbook were obtained. The researchers explained why this study was conducted and showed that textbooks are a major component of effective biology education. They also stated that teachers use textbooks as essential sources of information and assigning homework. The results of this study showed, however, the textbook, which is for 10th grade, was not suitable for international standards of science education. Questioning techniques were weak and there were some misconceptions. Visual materials did not serve the main aim of the subject.

Özay and Hasenekoğlu (2007) conducted another study. They aimed to investigate visual presentations and to locate disharmonies regarding 11th grade biology textbooks accepted by the MEB. They also focused on pictures, diagrams, illustrations, and graphs which were in the 11th grade biology textbook and showed

the misconceptions. This research was based on two criteria. The first criterion was the coherence between visual materials and the second criterion was logical order of the illustrations. The researchers used a descriptive qualitative research method.

Özay and Hasenekoğlu explained that, in Turkey, biology teachers use textbooks as a main source of teaching. Visual materials should be in the order of concrete to abstract, simple to complex and easy to hard. They also indicated that visual materials provided effective learning and helped students to understand concepts easier, especially in the area of biology. Lastly they showed that science textbooks included irrelevant pictures, diagrams, complex illustrations, and experiments which were impossible to perform. They concluded that in the textbooks which were investigated in this study, there were disharmonies between the orders of visual material and the visual material was not enough to explain the concepts. They suggested that, in high school for sufficient learning, diagrams and graphs have a significant role. Therefore, visual materials should be appropriate to the students' psychological level.

Özay and Hasenekoğlu (2006) examined whether the chapters of “reproduction, maturation and growth” in two 11th grade biology textbooks that were accepted by the Ministry of National Education-Board of Education (MEB-Talim Terbiye Kurulu). The authors aimed to discuss if the textbooks were sufficient in terms of scientific content or not. They used qualitative research methods and a survey instrument. They chose two 11th grade high school biology textbooks. In these textbooks, there were two types of mistakes: information and explanation. Textbooks included scientific mistakes and these caused some misconceptions. They also indicated that there were explanation errors and wrong information in both textbooks

within the chapters of “Reproduction; Maturation and Growth “. The two textbooks were not sufficient in terms of scientific content. They summarized by giving the reasons why these textbooks were insufficient and making recommendations for future textbooks.

Ünsal and Güneş (2002) investigated the physics unit of 4th grade elementary school science textbooks prepared by the MEB. Textbooks were investigated in terms of physics contents, educational conception, visual presentation, and language and expression method. They discovered that the textbooks contained errors in terms of visual presentation, educational conception and language. At the end of the study, researchers suggested solutions.

Korkmaz (2006) investigated 9th grade history textbooks and evaluated students’ and teachers’ opinions. The researcher used a survey to collect data from students and teachers. At the end of the study, the findings showed deficiencies in the textbooks and suggested solutions.

Sağlam (2012) conducted another textbook analysis study. This researcher analyzed quadratic chapters of mathematics textbooks from Turkey, Singapore and the IBDP. This researcher focused on content, organization and presentation style of textbooks using a content analysis as the method of this study. She found that the Turkish textbook covered more outcomes for quadratics than among other textbooks. While the Turkish textbook reflected mathematical concepts in inductive way from quadratic equations to functions, other textbooks reflected mathematical concepts in deductive way from quadratic functions to equations. Moreover, the Turkish textbook was richer than the other textbooks in terms of student-centered activities.

İnanç Gök (2012) is another researcher who conducted a textbook analysis study. She analyzed cellular respiration and photosynthesis chapters of biology textbooks from the MEB and the IBDP. The content analysis study depended on the perspectives of content, presentation and learning strategies of textbooks. Moreover, biology teachers' opinions were included as support evidence to the findings. İnanç Gök found that the MEB textbook covers more topics in detail. While the MEB textbook was richer in terms of student-centered activities, the IBDP textbook was richer in terms of technology. Moreover, neither the MEB textbook nor the IBDP textbook focused on higher order cognitive levels in assessment.

Ghazi, Ali, Shahzada, Khan and Nawaz (2011) in Pakistan analyzed 9th grade biology textbooks to understand the views of students and teachers regarding the diagrams and suitability of the content with its difficulty level. An open-ended questionnaire was prepared by the researchers to conduct this study. At the end of the study, they recommended that each chapter of the textbook relate to previous knowledge of students. Also the subject matter must be free from errors and should be appropriate for the intended age level.

The coverage of ecology units in biology curricula

The importance of ecology

Erol and Gezer (2006) stated that developments in science and technology have badly affected the interaction of human beings and nature. As a result, ecological balance has been altered. The extinction of species, desertification, starvation, poverty, radioactive pollution, and acid rain have become the problems of humanity

and human beings have rallied to seek solutions. They suggested that environmental education plays a large role in solving environmental problems.

Education is one of the most effective ways to make people aware of the importance of environmental protection. The protection of the environment becomes possible if those who badly affect the environment are educated. If society is not educated regarding the environment people will continue consuming living organisms and causing air and water pollution. People often think that they are the owners of the planet and are not aware of future generations (Arslan, 1997).

Magnus, Martinez, and Pedauye (1997) indicated that the goal of environmental education is to identify environmental problems and find solutions and finally, to create environmental behavior.

In Turkey, the aim of environmental education is to train students to become individuals who are aware of the environment. This is possible only if ecological topics in the biology curriculum are taught in an understandable and clear way. The ecology topics in the biology curriculum are important to teach interactions between living organisms and their environment (Atik, 2008).

Effective environmental education should help to train individuals to be aware of environmental problems and their responsibilities to solve these problems. Around the world increasing human population and development with science and technology has rapidly increased human needs. Humans have consumed natural resources in an increasing manner and have used technology in an uncontrolled way to satisfy their needs (Atik, 2008).

The context of ecology unit in MEB, IBDP and IGCSE curricula

Ministry of National Education and biology

The general aim of the Turkish education system is to provide development in social, cultural, and economic life and to increase happiness and welfare in Turkish society (MEB, 2002).

In 2012, MEB changed the related law of education by increasing compulsory education to 12 years from eight. Compulsory education is comprised of primary school (1, 2, 3, 4 grades), middle school (5, 6, 7, 8 grades) and secondary years (9, 10, 11, 12 grades) (MEB, 2012b).

Teaching biology starts with science lessons in year 4. Before that students learn life science which is basic terminology for biology. Then, it continues with middle school. Ecology unit formally begins to be taught at secondary years.

Ecology related units in MEB textbooks are delivered in four grades.

Grade 9 textbooks deliver the topics below:

1. Environmental Issues
2. Atatürk's opinions about nature and environment

The Ecology of Ecosystems unit in grade 10 covers the topics below:

1. The structure of ecosystem
2. The energy flow and cycles of matter
3. The importance of ecosystem

The Ecology of Community and Population unit in grade 11 covers the topics below:

1. The ecology of community
2. The ecology of population
3. Biomes

In grade 12 the topics are:

1. The importance of sustainability of matter and food sources
2. Conservation of biodiversity
3. Rehabilitation of environment and environmental awareness (MEB, 2011a, 2011b, 2011c, 2011d)

It should be noted that a new biology curriculum was developed while this study was in progress. As a result of this change, how the topics in ecology unit are distributed at different years of secondary school was not possible to consider as this study was almost at the final stage. According to new curriculum, ecology topics again spread from 9th grade to 12th, except 11th grade. Ninth grade covers Current Environmental Issues, while 10th grade covers Ecosystem Ecology and Biomes. Grade 12 covers Community and Population ecology topics (MEB, 2013).

International Baccalaureate Diploma Programme and biology

International Baccalaureate (IB) is an educational foundation founded in 1968.

According to International Baccalaureate Organization (IBO), its program provides development for students' intellectual, personal, emotional, and social skills. These skills help students to live, work, and learn in a rapidly globalizing World. The IB offers three programs for students aged 3 to 19. These are the Primary Years Programme (PYP), the Middle Years Programme (MYP) and the Diploma

programme (IBDP). PYP, for pupils aged 3 to 12, focuses on the development of the whole child in the classroom and in the world outside. MYP, for students aged 11 to 16, provides a framework of academic challenge and life skills through embracing and transcending traditional school subjects. The Diploma programme (IBDP) is designed for students aged 16 to 19 and is a demanding two-year curriculum that meets the needs of highly motivated students and leads to a qualification that is recognized by leading universities around the world (IBO, 2013 a).

Turkey is a member of the International Baccalaureate Africa Europe and Middle East (IBAEM) regional office which aims to improve education in both private and state schools. In 1994, one Turkish school was authorized by the IBO to become an IB world school. This date was the beginning for IB schools in Turkey. In 1996 the Turkish Ministry of National Education accepted the Uluslararası Bakalorya Diploma Programı (UBDP) (Halıcıoğlu, 2008).

In 2013, 42 schools offer one or more of three IB programmes in Turkey. Fourteen schools offer the PYP, seven schools offer the MYP and 30 schools offer the DP (IBO, 2013b).

In Turkey, particularly within private schools, one or more IB programmes are offered. Besides this situation, the MEB looked for the possibility of state school offering IB and in 2007 Prof. Dr. Mümtaz Turhan Social Sciences High School in İstanbul became an IB world school (Halıcıoğlu, 2008; Prof. Dr. Mümtaz Turhan Social Sciences High School, 2007).

The common aim of IB programmes is to educate people as internationally minded individuals who recognize their humanity. They are expected to have responsibility

toward protecting the planet and trying to create a better and peaceful world. The IB learner profile strives to obtain the following characteristics: “inquirers, knowledgeable, thinkers, communicators, principled, open-minded, caring, risk-takers, balanced, and reflective” (IBO, 2007, p.5).

The extended essays, Theory of knowledge (TOK), and Creativity, Action, Service (CAS) are core components of the IBDP curriculum. An extended essay is required to engage students in an independent research for one of the DP subjects. The TOK requires critical thinking and aims to deepen students’ understanding of knowledge. CAS is an involvement of students in activities parallel to their academic life, while action is about physical activities for a healthy life, and service is about learning within the community (IBO, 2013a).

Assessment consists of written examinations which are administered at the end of the programme. Assessment is criterion-related and marks range from 1 to 7. The diploma requirement is at least 24 points. TOK, and the extended essay points are part of the requirement. Moreover, CAS participation from students should be satisfactory (IBO, 2013a).

Biology is one of the Group 4: Experimental Sciences subjects. Biology may be studied at higher level and standard level. A compulsory project provides an opportunity for students to explore scientific solutions to global questions (IBO, 2013a).

According to the biology guide of IBDP (2007), the Group 4 assessment consists of external and internal components. External assessment is moderated by IBO and internal assessment is the responsibility of teachers. External assessment includes

three written papers. Paper 1 (20% for Standard Level (SL) and Higher Level (HL)) is made up of 40 multiple-choice questions. Paper 2 (32% for SL and 36% for HL) has two sections: section A and section B. Section A consists of one data-based question and short answers. Section B consists of two extended-response questions. Paper 3 (24% for SL and 20% for HL) contains several short answer questions and one extended-response question. Internal assessment is flexible for teacher so that they can choose their practical investigations. The requirement for Group 4 projects (24%) is 10 hours for both SL and HL students. The HL students are expected to spend 60 hours on practical activities and SL students are expected to spend 40 hours on practical activities.

The International Baccalaureate curriculum gives Topic 5, Ecology and Evolution as a core topic. In addition, in the option G gives Ecology and Conservation as a topic.

Topic 5: Ecology and Evolution covers sub-topics as stated below:

- 5.1 Communities and ecosystems
- 5.2 The greenhouse effect
- 5.3 Populations

Option G: Ecology and Conservation covers sub-topics that stated below:

- G1 Community ecology
- G2 Ecosystems and biomes
- G3 Impacts of humans on ecosystems
- G4 Conservation of biodiversity (IBO, 2007)

International General Certificate of Secondary Education and Biology

Cambridge International Examinations (CIE) provide international education programmes for students who are 5-19 years old. The mission of the Cambridge International Examinations is delivering world-class international education with the help of curricula, assessment, and services (CIE, 2013).

Cambridge IGCSE is an international curriculum for students who are 14-16 years old. IGCSE prepares students for their next steps in education (CIE, 2013).

Cambridge educated students who take the IGCSE are expected to be “confident, responsible, innovative and engaged individuals in society” (CIE, 2011, p.5).

Assessments are written, oral, and practical and coursework options for learners (CIE, 2011).

Biology is one of the IGCSE science subjects. Moreover, students learn the bad and good effects of science on the environment, individuals, and communities (CIE, 2011).

Grades ranges from A to G. Students are expected to enter three papers. Paper 1 (30%) is compulsory for all students and consists of multiple-choice questions. Students can take either Paper 2 (50%) or Paper 3 (50%). Moreover, students can take either Paper 4 (20%) or Paper 5 (20%) or Paper 6 (20%). Paper 2 is a core theory paper, Paper 3 is extended theory paper, Paper 4 is coursework, Paper 5 is a practical test and Paper 6 is an alternative to the practical paper (CIE, 2012).

IGCSE delivers the topics that stated below:

1. Energy flow

2. Food chains and food webs
3. Nutrient cycles
4. Population size
5. Human influences on the ecosystem

Conclusion

Biology teachers use textbooks as fundamental resources of teaching. Moreover, textbooks are useful for students to use in learning and preparing their homework. Therefore, an analysis of textbooks is important because it can demonstrate which textbooks are better for biology teaching. In addition, textbook analysis studies can provide suggestions for textbook writers.

Textbook evaluation and investigation studies are available but there is no comparison study in terms of ecology units. This review shows that there is a need for textbook analysis and comparison studies in terms of ecology units among MEB, IBDP and IGCSE curricula.

CHAPTER 3: METHOD

Introduction

The aim of this study is to analyze and compare the ecology topics of textbooks that deliver MEB, IBDP and IGCSE curricula with regard to content, presentation and learning. This study was conducted to address the following research questions:

- 1) Which biology textbook has the best coverage of ecology units within MEB, IBDP and IGCSE curricula, when evaluated according to FLDOE evaluation criteria?

Sub-questions:

- How do biology textbooks cover ecology-related topics in MEB, IBDP and IGCSE in terms of content (alignment with curriculum requirements, level of treatment, expertise for content development, accuracy of content, currentness of content, authenticity of content, multicultural representation, humanity and compassion)?
- How do biology textbooks cover ecology-related topics in MEB and IBDP in terms of presentation (comprehensiveness of student and teacher resources, alignment of instructional components, organization of instructional materials, logical organization, readability of instructional materials, pacing of content, ease of materials use)?
- How do biology textbooks cover ecology-related topics in MEB and IBDP in terms of learning (motivational strategies, teaching a few “Big Ideas”,

explicit instruction, guidance and support, active participation of students, targeted instructional assessment strategies, instructional strategies and assessment techniques)?

2) What are the opinions of biology teachers who use MEB, IBDP and IGCSE textbooks as a source of instructional material about content, presentation and learning of these textbooks?

This chapter describes the strategy of analysis of the MEB, the IBDP and the IGCSE biology textbooks with regard to content, presentation, and learning. In addition, research design, context, instrumentation, method of data collection and analysis is described.

Research design

This research study is designed as a qualitative study using content analysis and interview as the research methods. The opinions of biology teachers were also taken by semi-structured interview technique to provide a multi-dimensional perspective. The purpose of using more than one source to collect data was to provide supportive evidence for triangulation (Olsen, 2004; Guion, Diehl & McDonald, 2012).

According to Colorado State University (2012), content analysis is used as a research tool to present the words or concepts within texts which are normally defined as books and book chapters, discussions, essays, articles, newspaper headlines, speeches, historical documents, advertising, theater, informal conversation and interviews.

This study consists of content analysis in two stages. In the first stage, 9th, 10th, 11th, 12th grade MEB biology textbooks, one IBDP textbook and one IGCSE textbook were analyzed and compared in terms of ecology topics, utilizing criteria prepared by the FLDOE (2008). These criteria consist of three main perspectives: content, presentation, and learning.

In the second stage of this study, semi-structured interviews were conducted with biology teachers who were teaching MEB, IBDP, and IGCSE biology in three private high schools. The interviews were designed to obtain their opinions about content, presentation, and learning perspectives of the textbooks. Interviews were conducted face-to-face or with the assistance of Skype. Each interview lasted between 25 to 30 minutes. The second stage of study was conducted to support first stage by increasing validity of data (Guion, 2002).

In the semi-structured interviews, questions were prepared beforehand with the interviews being conversational. In this way, the interviewer can arrange the order of questions or ask them in other words. The interviewer can also explain questions and can skip redundant questions. Interviewees can talk freely and give information in detail (West Lothian Council Psychological Services, 2013).

This study was mainly designed as a qualitative study. However, quantitative results were used to support qualitative results. Numbers of pages, analogies, life connections, box types were given as quantitative results.

Context

The six ecology-related units were analyzed in the textbooks presented in Table 1.

Table 1
Textbooks analyzed in this study

MEB	Akkaya S., E., Sađdıç, D., Albayrak, O., Öztürk, E., & Cavak, Ş., (2011). <i>Ortaöğretim Biyoloji 9</i> . (pp.204-248). Ankara: MEB Yayınları.
MEB	Akkaya S., E., Sađdıç, D., Albayrak, O., Öztürk, E., Cavak, Ş., & İlhan, F. (2011). <i>Ortaöğretim Biyoloji 10</i> . (pp.196-241). Ankara: MEB Yayınları.
MEB	Sađdıç, D., Albayrak, O., Öztürk, E., & Cavak, Ş., (2011). <i>Ortaöğretim Biyoloji 11</i> . (pp.200-252). Ankara: MEB Yayınları.
MEB	Committee. (2011). <i>Ortaöğretim Biyoloji 12</i> . (pp.214-239). Ankara: MEB Yayınları.
IBDP	Damon, A., McGonegal, R., Tosto, P., & Ward, W. (2007). <i>Heinemann Baccalaureate: Biology Higher Level for the IB Diploma</i> . (pp. 112-132, 552-600). Essex, UK: Pearson Education Limited.
IGCSE	Pickering R. (2006). <i>Complete Biology for IGCSE</i> . (pp.248-278). Oxford, UK: Oxford University Press.

The MEB textbooks are the main instructional material used to deliver the MEB curriculum in Turkey (Table 1). IBDP and IGCSE textbooks were selected among other possible textbooks. The IBDP and IGCSE textbooks selected for this study are seen as the most common textbooks that are used in Turkish schools. This researcher conducted teaching practice in IB school and observed teachers to determine which IBDP textbook was used in classrooms. Since two schools in Turkey which deliver IGCSE curriculum use the selected textbook, the IGCSE textbook was selected for analysis.

In this study, ecology-related units were selected for analysis and comparison. The reason for selecting ecology as a topic was that environmental issues have become important in today's world. According to Atik (2008), environmental awareness is only possible if ecology topics are taught completely and correctly. To teach the relationships between events which happen in nature between living organisms and their environment, ecology topics in the high school biology curriculum have an important role.

Instrumentation

There are several types of evaluation criteria (FLDOE, 2008; Board of Education, 2012; The American Association for the Advancement of Science, 2005). However, priorities for evaluating instructional materials prepared by the FLDOE (2008) were selected for use. This material summarizes evaluation criteria of instructional materials published since 1999. At the FLDOE, educators and evaluation specialists identified the following major priorities for the evaluation of instructional materials: content, presentation, and learning.

For the first stage of this content analysis, the ecology topics of each of the textbooks were analyzed according to FLDOE (2008).

For the second stage of the content analysis, open-ended interview questions were prepared according to FLDOE criteria and used (Appendix E). The interviews were conducted with six biology teachers from three high schools. Interviews were conducted in Turkish and notes were taken during the interview.

Method of data collection and analysis

The ecology units of six textbooks were analyzed in terms of content, presentation and learning perspectives with an instrument developed by Florida Department of Education (FLDOE, 2008) for textbook analysis purposes.

Two other reviewers (Master's students in the field of curriculum and instruction) helped this researcher to analyze some perspectives of the listed criteria. If the results of analysis for any part of the criteria were similar, they were accepted as correct

classification. If there were no agreement among reviewers, the results were discussed again until agreement was reached.

Microsoft Word was used to construct tables and Microsoft Excel was used to draw graphs. A calculator was used to calculate percentages. Websites were helpful to calculate readability (Edit Central, 2012; Fatih University, 2012).

The framework for the textbook analysis used is presented in Table 2.

Table 2
Headings and sub-headings of criteria used in textbook analysis

Content	Presentation	Learning
<ul style="list-style-type: none"> • Alignment with curriculum requirements • Level of treatment • Expertise for content development • Accuracy of content • Currentness of content • Authenticity of content • Multicultural representation • Humanity and compassion 	<ul style="list-style-type: none"> • Comprehensiveness of student and teacher resources • Alignment of instructional components • Organization of instructional materials • Logical organization • Readability of instructional materials • Pacing of content • Ease of materials use 	<ul style="list-style-type: none"> • Motivational strategies • Teaching a few “Big Ideas” • Explicit instruction • Guidance and support • Active participation of students • Targeted instructional assessment strategies • Instructional strategies and assessment techniques

Content

To analyze the ecology content six of selected textbooks, the sub-headings (given in Table 2) were used. Explanations for each of these sub-headings were given below.

Alignment with the curriculum requirements

MEB, IBDP, and IGCSE curricula were investigated in terms of aims, objectives, approaches, features and scope of ecology-related units and the findings were presented in the tables (Tables 3, 4, 5).

To understand the curriculum requirements, the objectives of ecology-related units were presented for comparison (Tables 6, 7, 8, 9).

Level of treatment

Under this sub-heading, six selected textbooks were analyzed in terms of complexity, objectives, students, and time for teaching.

While textbooks were being investigated, the terms given in textbooks, topics, language style, and activities were considered. Appropriateness for students' age and grade level was also considered.

The amount of time allocated to the teaching of the ecology units in each curriculum is presented in Tables 10, 11 and 12, comparing the six selected textbooks.

Expertise for content development

Firstly, the six selected textbooks were checked to analyze whether the writers' name of the textbooks is stated or not. Secondly, further information regarding the author or authors is considered. Finally, other experts cited in the books were checked to find information regarding them.

Accuracy of content

In this section, the six selected textbooks were read page by page and scientific mistakes were detected. The findings were presented in Table 13.

Visuals were checked in terms of quality and effectiveness. Problematic visuals were scanned and presented as examples (Figure 1).

Currentness of content

The six selected textbooks were checked for their publication dates. The findings were stated in later in this section. Visuals were evaluated in terms of currentness.

Authenticity of content

In this section, the six selected textbooks were read page by page to find life connections and interdisciplinary treatment.

Life connections from each textbook were counted and the examples divided according to the sub-headings of textbooks. Then, the results were stated as a table (Table 14).

To find interdisciplinary treatment in textbooks, examples and visuals were considered.

Multicultural representation

In this section, texts, visuals, and boxes were checked in terms of gender, age, disability, national origin, and any religious concepts.

Humanity and compassion

The six selected textbooks were read to find any examples of criticism, inhumane treatment, and sexism.

Presentation

To analyze the six selected textbooks on presentation, the sub-headings (given in Table 2) were used. Explanations for each of these sub-headings were indicated below.

Comprehensiveness of student and teacher resources

In this section, firstly, six selected textbooks were checked to see whether they provide teacher resource or not. Web-searching was conducted to locate related teacher resources with textbooks. Teachers' resources kit was also checked in terms of content and, findings were presented.

Alignment of instructional components

The MEB textbook and the IBDP textbooks did not contain a link to any resources for teachers, so only the IGCSE textbook was analyzed in this respect. Teachers' resource kits were checked from the Internet to investigate the content of the package. The IGCSE textbook, the IGCSE biology syllabus and the teachers' resource kits were compared to evaluate their alignment with each other.

Organization of instructional materials

In this section, the six selected textbooks were evaluated regarding whether objectives were presented or not. Moreover, some features which were helpful in locating and searching for information were checked and the results were presented in Table 15.

Additionally, the Table of Contents page of the MEB textbook was scanned and added to the findings (Figure 2).

Visuals cues of the selected textbooks were checked page by page and the results were stated. Example of a visual cue from the IGCSE textbook was scanned and added (Figure 3). Boxes were presented in each textbooks were counted and the

results were presented in Tables 18 and 19. Examples of boxes from each textbook were scanned and added to the findings (Figures 4, 5, 6).

Visual structure of six selected textbooks was investigated and results were presented in Table 17. Since, the MEB textbooks have online access it could be easier to state font style. On the other hand, IBDP and IGCSE textbook do not have online access, one page from each textbook was scanned and font types of texts were deduced.

The pages of ecology related units were counted and the percentage was calculated. The results were presented in Table 16.

Finally, visuals of the six selected textbooks were counted and classified according to their types. The visuals contribute readability when they serve instructional purpose. In Table 24, the numbers of visuals were given.

Logical organization

In this section, the six selected textbooks were investigated in terms of headings and sub-headings. The headings and sub-headings of the ecology units of each textbook were presented in Tables 20, 21, 22 and 23.

Readability of instructional materials

The readability of the six selected textbooks was calculated according to Flesch's formula and Ateşman's formula. Ateşman's readability formula is an adapted version of Flesch's formula for Turkish texts (Özay, 2009). The readability of the four MEB textbook was calculated according to Ateşman's readability formula. The readability of the IBDP and the IGCSE textbooks was calculated according to Flesch's formula (Appendix D).

Three sections of 100 words are selected from the beginning, middle and end of a text or a textbook (Temur, 2003). Three paragraphs of 100 words were therefore selected randomly from the beginning, middle and end of each of the four textbooks (Appendix A, B, and C). Then, readability formulas were applied. Two websites were helpful in calculations (Edit central; Fatih University).

Visuals were classified and results were presented (Table 24).

Pacing of content

In this section, the cognitive load was considered in order to understand the pace of the textbooks. Blocks of information and bite-size chunks are important in cognitive load; hence textbooks were evaluated according to the presentation of information.

Ease of materials use

In this section, warranty, practicality of use, durability and cost of textbooks were considered. The weights of covers of the textbooks were checked in terms of ease of carrying. The costs of textbooks were obtained from the Internet.

Learning

To analyze the six selected textbooks on learning, the sub-headings (given in Table 2) were used and an explanation for each of the sub-headings was detailed below.

Motivational strategies

Language style of textbook, student activities and technology usage were considered when checking the motivational strategies of the six textbooks.

The six selected textbooks were read and the language style of textbook determined regarding each textbooks. To support the findings, examples from each textbook are given.

The types of student activities in six textbooks were noted. An example from a student activity was stated to show how it might motivate students.

The six textbooks were also checked in terms of technology links. The links in the IBDP textbook were reached via the Internet and the content of each website was analyzed.

Teaching a few “Big Ideas”

Big ideas here are key concepts in ecology-related units. An article regarding key principles of ecology and environmental education of Environmental Education and Training Partnership (2002) was used to determine the big ideas of the ecology-related topics. The categories were stated in Table 25 and the six selected textbooks were investigated to determine if they included big ideas or not. The results were given in Table 25 for comparison.

Explicit instruction

Each selected textbook was analyzed to determine if unit objectives were stated in the textbooks or not. Then, the introductions in each textbook were investigated to understand the clarity of the textbooks. Student activities were paid extra attention according to whether it was possible to conduct them easily, step by step. Since advance organizers are the part of explicit instruction, boxes are considered.

Guidance and support

The student activities were checked in the MEB textbooks. Types of student activities were classified and stated (such as, experiments, assignments, trips, designs, and projects). Boxes were considered as guidance strategy of textbooks. Related examples were given.

The way of presenting terms was investigated and the results are presented. The font styles of terms are given.

Finally, analogies were detected. The numbers of analogies were counted and presented in Table 26.

Active participation of students

The student activities of textbooks were taken into account in this section. The student activities were listed according to grade. The types of activities were stated in Table 27.

Targeted instructional assessment strategies

The objectives given per unit were classified according to Bloom's Cognitive Taxonomy levels. In this study, the analysis was the cognitive domain of Bloom's Taxonomy: knowledge, comprehension, application, analysis, synthesis and evaluation (Bloom, 1956; Yaşar University, 2010; Köğce, Aydın & Yıldız, 2009; Clemson University, 2013). The number of objectives in each taxonomy levels was counted (Figures 7, 8, 9).

Instructional strategies and assessment techniques

To determine assessment techniques of textbooks the questions were investigated in each textbook, and question types are determined. The numbers of questions were classified according to question type and presented as a graph (Figure 10).

CHAPTER 4: RESULTS

Introduction

The aim of this study was to analyze and compare ecology topics in the textbooks which cover the MEB, IBDP and IGCSE curricula with regard to content, presentation, and learning. In this chapter, the results of this analysis were presented.

After the completion of the analyses of the six textbooks, semi-structured interviews were conducted with biology teachers who used the MEB, the IBDP and the IGCSE textbooks.

Content

In the content section, the analysis results of the ecology units of the six selected textbooks were presented from eight perspectives. The perspectives used were those of the Florida Department of Education (FLDOE): (i) alignment with curriculum requirements, (ii) level of treatment, (iii) expertise for content development, (iv) accuracy of content, (v) currentness of content, (vi) authenticity of content, (vii) multicultural representation, (viii) humanity and compassion.

Alignment with curriculum requirements

The content of the ecology units of the six selected textbooks must align with curriculum requirements. Four textbooks cover the MEB curriculum, one textbook covers the IBDP curriculum and one textbook covers the IGCSE curriculum. Each textbook must align with the curriculum standards.

Below, the general information about the MEB, the IBDP, and the IGCSE curricula is given and then the analysis results presented in depth.

MEB, IBDP and IGCSE curricula

The MEB curriculum offers a four-year program. The IBDP offers a two-year program, and the IGCSE offers a two-year program.

The aims of the MEB biology curriculum are stated below:

Students;

- Understand the nature of science
- Improve their knowledge about how science contributes to culture by learning biology
- Develop knowledge, skills, attitudes and customs for better understanding of world
- Understand the importance of scientific values for individuals, society and environment
- Use biological knowledge to solve daily life problems
- Use scientific method as a solution for encountered problems
- Prepare themselves for biology related professions in terms of cognitive and affective skills
- Join different activities about recognition and conservation of biological richness of Turkey (MEB, 2011a, p.4).

In the IBDP, biology is one of the group 4: experimental science subjects. According to the biology guide, biology as an experimental science should aim to accomplish the following:

- Provide opportunities for scientific study and creativity within a global context that will stimulate and challenge students
- Provide a body of knowledge, methods and techniques that characterize science and technology
- Enable students to apply and use a body of knowledge, methods and techniques that characterize science and technology
- Develop an ability to analyze, evaluate and synthesize scientific information
- Engender an awareness of the need for, and the value of, effective collaboration and communication during scientific activities

- Develop experimental and investigative scientific skills
- Develop and apply the students' information and communication technology skills in the study of science
- Raise awareness of the moral, ethical, social, economic and environmental implications of using science and technology
- Develop an appreciation of the possibilities and limitations associated with science and scientists
- Encourage an understanding of the relationships between scientific disciplines and the overarching nature of the scientific method (IBO, 2007, p. 9)

The aims of the IGCSE biology syllabus are given below. In the syllabus, it is stated that aims are not listed in order of priority and that they are the same for all students.

- to provide a worthwhile educational experience for all candidates, through well-designed studies of experimental and practical science, whether or not they go on to study science beyond this level
- to enable candidates to acquire sufficient understanding and knowledge to:
 - ✓ become confident citizens in a technological world, to take or develop an informed interest in scientific matters
 - ✓ recognize the usefulness, and limitations, of scientific method and to appreciate its applicability in other disciplines and in everyday life
 - ✓ be suitably prepared for studies beyond the IGCSE in pure sciences, in applied sciences or in science-dependent vocational courses
- to develop abilities and skills that:
 - ✓ are relevant to the study and practice of biology
 - ✓ are useful in everyday life
 - ✓ encourage efficient and safe practice
 - ✓ encourage effective communication
- to develop attitudes relevant to biology such as:
 - ✓ concern for accuracy and precision
 - ✓ objectivity
 - ✓ integrity
 - ✓ enquiry
 - ✓ initiative
 - ✓ inventiveness
- to stimulate interest in, and care for, the environment
- to promote an awareness that:
 - ✓ scientific theories and methods have developed, and continue to do so, as a result of the co-operative activities of groups and individuals
 - ✓ the study and practice of science is subject to social, economic, technological, ethical and cultural influences and limitations

- ✓ the applications of science may be both beneficial and detrimental to the individual, the community and the environment
- ✓ science transcends national boundaries and that the language of science, correctly and rigorously applied, is universal (CIE, 2012, p.7)

Six features are presented in the curriculum: biological literacy, constructivist approach to learning, spiral structure, differentiated instruction, and parallelism and integrity with other disciplines and alternative assessment (MEB, 2011a).

The MEB biology curriculum design is based on social constructivism. Social constructivism is an effective method in teaching since collaboration and social interaction occur in the classrooms. According to Powell and Kalina (2009), Vygotsky believed that social interaction is an internal part of learning. In this theory, language development has a huge role. Assistance of teachers is another important key concept in social constructivism. Firstly the students perform the activities individually and see what they can do on their own then, with help from the teacher, students learn new concepts and achieve the activity. Therefore, the MEB biology curricula indicate that drama and project work could be used according to student-centered pedagogy.

The 9th grade MEB textbook includes classroom discussion activities, experiments, poster designing, newspaper writing, power point presentation, field trip and project work. The 10th grade MEB textbook covers activities such as model constructing, project work, self-learning activity, self-discussion activity, and poster designing activity. The 11th grade MEB textbook contains self-learning and group discussion activities. The 12th grade MEB textbook covers self-discussion and project work activities.

The MEB biology textbooks present highly matched activities with student-centered pedagogy and direct social constructivist approach of learning.

In the MEB biology curriculum, spiral structure is explained in that topics are spread from 9th grade to 12th grade rather than teaching in one specific grade. Topics are presented from simple to complex, known to unknown, concrete to abstract and in the each grade more detail is added to the previous grade's key concepts (MEB, 2011a).

With regard to ecology-related topics, they are presented from 9th grade to 12th grade.

In the MEB textbooks, separation of topics into grades aligns well with the spiral structure feature of curriculum. Ecology-related topics are shown in Table 3.

Table 3
Topics in ecology-related units of the MEB curriculum

Grade			
9	10	11	12
Environmental issues	Structure of ecosystem	Ecology of community	Sustainability of matter and food resources
The perceptivity of Atatürk about Nature and Environment	Energy flow and cycles of matter in ecosystem	Ecology of population	Conservation of biodiversity
	Importance of ecology	Biomes	Rehabilitation of environment and forming environmental awareness

While the MEB biology curriculum delivers ecology units within four years, the IBDP covers ecology topics as SL, HL and option G in two years, the last 2 years in high school. The IBDP ecology topics are presented in Table 4.

Table 4
Ecology topics in the IBDP curriculum

Topic 5: Ecology and evolution	Option G: Ecology and conservation
5.1 Communities and ecosystems	Core (SL and HL)
5.2 The greenhouse effect	G1 Community ecology
5.3 Populations	G2 Ecosystems and biomes
	G3 Impacts of humans on ecosystems
	Extension (HL only)
	G4 Conservation of biodiversity
	G5 Population ecology

Similar to the IBDP, the IGCSE cover ecology topics in two years. The IGCSE topics are presented in Table 5.

Table 5
Ecology topics in the IGCSE curriculum

Section 4: Relationships of organisms with one another and with their environment

1. Energy flow
 2. Food chains and food webs
 3. Nutrient cycles
 4. Population size
 5. Human influences on the ecosystem
 - 5.1 Agriculture
 - 5.2 Pollution
 - 5.3 Conservation
-

Differentiated instruction is another important feature of the MEB biology curriculum. The MEB notes that students may be different in terms of cognitive skills, learning types and strategies, motivational strategies. Therefore, teachers should apply different types of teaching methods and use different measurement and evaluation techniques (MEB, 2011a).

As mentioned earlier about the spiral structure of curriculum, topics are separated into grades and follow a flow from simple to complex, known to unknown, concrete to abstract. This flow is suitable for the differentiated instruction features of textbooks, and different types of students get benefit from this flow. Moreover, as explained in the social constructivist theory, activities show a wide variety. The teachers may apply different types of teaching methods using different measurement and evaluation techniques.

Alternative assessment is the other feature indicated in the MEB biology curricula: performances, portfolios, project work, concept maps, peer and self-assessment techniques are suggested for alternative assessment (MEB, 2011a).

The ecology-related units themselves contain activities such as project work, presentations, designing posters, and writing newspaper articles which could be used in alternative assessment.

In addition, MEB curriculum has three further sets of outcomes. They are: Science-Technology-Society-Environment (STSE), Communication Skills, Attitude and Values (CSAV), Scientific Investigations and Scientific Process Skills (SISPS).

STSE offers 33 outcomes. These outcomes are mainly related with the importance of science and biology in human life, nature of science and technology, relationship between science and technology, culture and history of science and interactions between science, technology, society and environments.

CSAV offers 20 outcomes with an emphasis on higher level thinking skills such as; awareness of cognitive skills, empathy, determination, honesty, desire for finding truths, entrepreneurship, personal and social awareness, targeting the best, critical thinking, delicacy and learning to learn. This group's outcomes are not given in objective tables.

SISPS offer 27 outcomes. These outcomes cover skills such as scientific inquiry, using scientific method during experiments and reporting the experiment results.

The Theory of Knowledge (TOK) and the international dimension are other important features that are indicated in the IB biology guide. TOK is one of the requirements for IBDP. In the teacher's notes, the syllabus gives references to appropriate topics for addressing scientific way of knowledge. In the syllabus, some international topics such as AIDS and climate change are also written. Group 4 students are encouraged to visit websites of international scientific organizations.

Ecology units in MEB, IBDP and IGCSE curricula

Ecology units of MEB, IBDP and IGCSE are listed below.

The ecology units are covered in four years in the MEB curricula. The objectives for each grade are given in Table 6.

Table 6
MEB objectives of ecology topics (MEB, 2011a, p. 64, 2011b, p.48, 2011c, p.50, 2011d, p. 56)

MEB Objectives			
9 th grade	10 th grade	11 th grade	12 th grade
<ul style="list-style-type: none"> •Explain the reasons and results of environmental issues with the help of examples •Examine the role in the environmental issues as an individual •Explain the effects of environmental issues on human health with the help of examples •Suggest solutions for environmental issues •Participate to activities related with the solutions of environmental issues •Give examples from Atatürk's memories, opinions, and ideas about environment 	<p>The structure of the ecosystem:</p> <ul style="list-style-type: none"> •Explain the relationship between population, community and ecosystem with the help of examples •Discuss the interaction between abiotic and biotic factors <p>Energy flow and cycles of matter:</p> <ul style="list-style-type: none"> •Identify the role of producer, consumer and decomposers •Comment the relationship between food chain, food web and food pyramid •Explain the energy flow on energy pyramid •Show the cycles of matter on diagram and explain the importance 	<p>Community ecology:</p> <ul style="list-style-type: none"> •Explain the structure of community and the factors that affect community with the help of examples •Explain the competition between inner species and inter species with the help of examples •Explain the symbiosis on inter species with the help of examples •Explain primary and secondary succession on the example <p>Population ecology:</p> <ul style="list-style-type: none"> •Explain population dynamic and carrying capacity •Explain the reasons for endangered species •Suggest the results of extensive growth in population 	<p>Sustainability of matter and food resources:</p> <ul style="list-style-type: none"> •Explain the importance of matter and food resources for life with the help of examples •Discuss the importance of sustainability of matter and food resources <p>Conservation of biodiversity:</p> <ul style="list-style-type: none"> •Deduce the importance of conservation of terrestrial and aquatic biodiversity •Outline the precaution for sustainability of biodiversity •State the importance of conservation of local species that are used in agriculture and stockbreeding <p>Rehabilitation of environment and awareness of environment:</p> <ul style="list-style-type: none"> •Discuss the rehabilitation of damaged environment
		<p>Biomes:</p> <ul style="list-style-type: none"> •Describe the factors that affect the dispersion of plants and animals •Explain the relationship between biome and ecosystem •Identify the features of basic aquatic and terrestrial biomes in the world 	<ul style="list-style-type: none"> •Join the activities as a volunteer related with rehabilitation of environment •State examples for the relationship between environmental ethic, conservation of environment and sustainable progress

The IBDP curriculum presents ecology topics in Topic 5 and Option G. The objectives of the ecology topics are given in Table 7 and Table 8.

Table 7

IBDP objectives for Topic 5 (IBDP, 2007, pp. 63-66)

IB-Topic 5	
<p>Communities and ecosystems</p> <ul style="list-style-type: none"> •Define species, habitat, population, community, ecosystem and ecology. •Distinguish between autotroph and heterotroph. •Distinguish between consumers, detritivores and saprotrophs. •Describe what is meant by a food chain, giving three examples, each with at least three linkages (four organisms). •Describe what is meant by a food web. •Define trophic level. •Deduce the trophic level of organisms in a food chain and a food web. •Construct a food web containing up to 10 organisms, using appropriate information. •State that light is the initial energy source for almost all communities. •Explain the energy flow in a food chain. •State that energy transformations are never 100% efficient. •Explain reasons for the shape of pyramids of energy. •Explain that energy enters and leaves ecosystems, but nutrients must be recycled. •State that saprotrophic bacteria and fungi (decomposers) recycle nutrients. 	<p>The greenhouse effect</p> <ul style="list-style-type: none"> •Draw and label a diagram of the carbon cycle to show the processes involved. •Analyze the changes in concentration of atmospheric carbon dioxide using historical records . •Explain the relationship between rises in concentrations of atmospheric carbon dioxide, methane and oxides of nitrogen and the enhanced greenhouse effect. •Outline the precautionary principle. •Evaluate the precautionary principle as a justification for strong action in response to the threats posed by the enhanced greenhouse effect. •Outline the consequences of a global temperature rise on arctic ecosystems. <p>Populations</p> <ul style="list-style-type: none"> •Outline how population size is affected by natality, immigration, mortality and emigration. •Draw and label a graph showing a sigmoid (S-shaped) population growth curve. •Explain the reasons for the exponential growth phase, the plateau phase and the transitional phase between these two phases. •List three factors that set limits to population increase.

Table 8

IBDP objectives for Option G (IBDP, 2007, pp.114-119)

Option G: Ecology and conservation	
<p>Community ecology</p> <ul style="list-style-type: none"> •Outline the factors that affect the distribution of plant species, including temperature water, light, soil pH, salinity and mineral nutrients. •Explain the factors that affect the distribution of animal species, including temperature, water, breeding sites, food supply and territory. •Describe one method of random sampling, based on quadrat methods, that is used to compare the population size of two plant or two animal species. •Outline the use of a transect to correlate the distribution of plant or animal species with an abiotic variable. •Explain what is meant by the niche concept, including an organism's spatial habitat, its feeding activities and its interactions with other species. •Outline the following interactions between species, giving two examples of each: competition, herbivory, predation, parasitism and mutualism. 	<p>Impacts of humans on ecosystems</p> <ul style="list-style-type: none"> •Calculate the Simpson diversity index for two local communities. •Analyse the biodiversity of the two local communities using the Simpson index. •Discuss reasons for the conservation of biodiversity using rainforests as an example. •List three examples of the introduction of alien species that have had significant impacts on ecosystems. •Discuss the impacts of alien species on ecosystems. •Outline one example of biological control of invasive species. •Define biomagnification. •Explain the cause and consequences of biomagnification, using a named example.

Table 8 (Cont'd)
IBDP objectives for Option G (IBDP, 2007, pp.114-119)

<ul style="list-style-type: none"> • Explain the principle of competitive exclusion. • Distinguish between fundamental and realized niches. • Define biomass. • Describe one method for the measurement of biomass of different trophic levels in an ecosystem. <p>Ecosystems and biomes</p> <ul style="list-style-type: none"> • Define gross production, net production and biomass. • Calculate values for gross production and net production using the equation: gross production – respiration = net production. • Discuss the difficulties of classifying organisms into trophic levels. • Explain the small biomass and low numbers of organisms in higher trophic levels. • Construct a pyramid of energy, given appropriate information. • Distinguish between primary and secondary succession, using an example of each. • Outline the changes in species diversity and production during primary succession. • Explain the effects of living organisms on the abiotic environment, with reference to the changes occurring during primary succession. • Distinguish between biome and biosphere. • Explain how rainfall and temperature affect the distribution of biomes. • Outline the characteristics of six major biomes. 	<ul style="list-style-type: none"> • Outline the effects of ultraviolet (UV) radiation on living tissues and biological productivity. • Outline the effect of chlorofluorocarbons (CFCs) on the ozone layer • State that ozone in the stratosphere absorbs UV radiation. <p>Conservation of biodiversity</p> <ul style="list-style-type: none"> • Explain the use of biotic indices and indicator species in monitoring environmental change • Outline the factors that contributed to the extinction of one named animal species. • Outline the biogeographical features of nature reserves that promote the conservation of diversity. • Discuss the role of active management techniques in conservation. • Discuss the advantages of in situ conservation of endangered species (terrestrial and aquatic nature reserves) • Outline the use of ex situ conservation measures, including captive breeding of animals, botanic gardens and seed banks. <p>Population ecology</p> <ul style="list-style-type: none"> • Distinguish between r-strategies and k-strategies. • Discuss the environmental conditions that favour either r-strategies or k-strategies. • Describe one technique used to estimate the population size of an animal species based on a capture–mark–release–recapture method • Describe the methods used to estimate the size of commercial fish stocks. • Outline the concept of maximum sustainable yield in the conservation of fish stocks. • Discuss international measures that would promote the conservation of fish.
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The IGCSE curriculum presents ecology topics in Section 4. The objectives of Section 4 are given in Table 9.

Table 9
IGCSE objectives for Section 4 (CIE, 2012, pp. 37-40)

IGCSE Section 4	
Core	Supplement
<p>1. Energy flow</p> <ul style="list-style-type: none"> • State that the Sun is the principal source of energy input to biological systems • Describe the non-cyclical nature of energy flow 	
<p>2. Food chains and food webs</p> <ul style="list-style-type: none"> • Define the terms: • <i>food chain</i> as a chart showing the flow of energy (food) from one organism to the next beginning with a producer (e.g. mahogany tree → caterpillar → song bird → hawk) 	<ul style="list-style-type: none"> • Explain why food chains usually have fewer than five trophic levels • Explain why there is an increased efficiency in supplying green plants as human food and that there is a relative inefficiency, in terms of energy loss, in feeding crop plants to animals

Table 9 (Cont'd)

IGCSE objectives for Section 4 (CIE, 2012, pp. 37-40)

- *food web* as a network of interconnected food chains showing the energy flow through part of an ecosystem
 - *producer* as an organism that makes its own organic nutrients, usually using energy from sunlight, through photosynthesis
 - *consumer* as an organism that gets its energy by feeding on other organisms
 - *herbivore* as an animal that gets its energy by eating plants
 - *carnivore* as an animal that gets its energy by eating other animals
 - *decomposer* as an organism that gets its energy from dead or waste organic matter
 - *ecosystem* as a unit containing all of the organisms and their environment, interacting together, in a given area e.g. decomposing log or a lake
 - *trophic level* as the position of an organism in a food chain, food web or pyramid of biomass, numbers or energy
 - Describe energy losses between trophic levels
 - Draw, describe and interpret pyramids of biomass and numbers
-

3. Nutrient cycles

- Describe the carbon and the water cycles

- Describe the nitrogen cycle in terms of:
 - the role of microorganisms in providing usable nitrogen-containing substances by decomposition and by nitrogen fixation in roots
 - the absorption of these substances by plants and their conversion to protein
 - followed by passage through food chains, death, decay
 - nitrification and denitrification and the return of nitrogen to the soil or the atmosphere (names of individual bacteria are not required)
 - Discuss the effects of the combustion of fossil fuels and the cutting down of forests on the oxygen and carbon dioxide concentration in the atmosphere
-

4. Population size

- Define *population* as a group of organisms of one species, living in the same area at the same time
 - State the factors affecting the rate of population growth for a population of an organism (limited to food supply, predation and disease), and describe their importance
 - Identify the lag, exponential (log), stationary and death phases in the sigmoid population growth curve for a population growing in an environment with limited resources
 - Describe the increase in human population size and its social implications
 - Interpret graphs and diagrams of human population growth
-

- Explain the factors that lead to the lag phase, exponential (log) phase and stationary phase in the sigmoid curve of population growth making reference, where appropriate, to the role of limiting factors
-

5. Human influences on the ecosystem

- Outline the effects of humans on ecosystems, with emphasis on examples of international importance (tropical rain forests, oceans and important rivers)
- ##### 5.1 Agriculture
- List the undesirable effects of deforestation (to include extinction, loss of soil, flooding, carbon dioxide build up)
-

Table 9 (Cont'd)

IGCSE objectives for Section 4 (CIE, 2012, pp. 37-40)

<ul style="list-style-type: none">• Describe the undesirable effects of overuse of fertilisers (to include eutrophication of lakes and rivers)	
5.2 Pollution	
<ul style="list-style-type: none">• Describe the undesirable effects of pollution to include:<ul style="list-style-type: none">• water pollution by sewage and chemical waste• air pollution by sulphur dioxide• air pollution by greenhouse gases (carbon dioxide and methane) contributing to global warming• pollution due to pesticides including insecticides and herbicides• pollution due to nuclear fall-out	<ul style="list-style-type: none">• Discuss the effects of non-biodegradable plastics in the environment• Discuss the causes and effects on the environment of acid rain, and the measures that might be taken to reduce its incidence
5.3 Conservation	
<ul style="list-style-type: none">• Describe the need for conservation of: species and their habitats• natural resources (limited to water and non-renewable materials including fossil fuels)	<ul style="list-style-type: none">• Explain how increases in greenhouse gases (carbon dioxide and methane) are thought to cause global warming

Level of treatment

The complexity of the content presented must be at the appropriate level. Objectives, students, and time for teaching constitute the level of treatment. Thus, the analyses were conducted according to these features.

The order of the ecology units in the MEB textbooks meet with these objectives.

The topics start from simple and move to complex, starting with ecology-related topics in the 9th grade and continuing to the 12th grade.

In the 9th grade, the topics are Environmental Issues and the Perceptivity of Atatürk about Nature and Environment. They are appropriate for the age level of 9th grade students since they focus on social aspect of ecology. In the 10th grade, the topics are Structure of Ecosystem, Energy flow and cycles of matter in ecosystem and Importance of ecology. Order of topics meets the objectives of the MEB 10th grade curriculum. In the 11th grade, the topics are Community ecology, Population ecology

and Biomes. The 10th and 11th grade topics include more terminology than the 9th grade which makes them suitable for older age levels. Therefore, grade 10 and grade 11 topics meet the objectives for the age level of students. Finally, the 12th grade textbook presents Sustainability of matter and food resources, Conservation of biodiversity and Rehabilitation of environment and forming environmental awareness. Compared to grades 10 and 11, the grade 12 topics focus on more social aspects of ecology, topics which meet with objectives.

The presentation of the MEB textbooks is understandable and something like storytelling. The units start with information, text or a poem and questioning is used to create warm language for students. Moreover, the questioning makes students think about ecological concepts. All units have activities throughout the explanations. At the end of the each section and unit there are evaluation questions.

The IBDP presents ecology topics in Topic 5 and Option G part of the textbook. The topics meet the objectives of the IB biology curriculum. The topics for Topic 5: Ecology and Evolution are Communities and Ecosystems, the Greenhouse effect and Populations. In Option G topics presented are Community Ecology, Ecosystems and Biomes, Impacts of Humans on ecosystems for both SL and HL students.

Conservation of biodiversity, Population ecology topics are only for HL students.

Compared with the MEB curriculum, Topic 5 of the IBDP textbook covers only small parts of the MEB textbooks for grade 10 and 11 without Option G. Topic 5 and Option G together cover the MEB curriculum for grades 10, 11 and 12.

The IBDP textbook does not suggest any activities or experiments throughout the explanation. Only at the end of the unit, exercises and practice questions are

presented. The language of this textbook is more scientific compared with the MEB textbook.

The IGCSE textbook does not suggest any experiments or activities, as the IBDP textbook does. At the end of the unit and throughout the unit, questions are given for students to practice. The language of the textbook is more scientific compared to the MEB and the IBDP.

The IGCSE biology syllabus stated that time for Section IV: Relationships of organisms with one another and with their environment is 20% of total teaching time. Time is given for teaching ecology topics both in the MEB and the IBDP curricula presented in Tables 10, 11 and 12 below.

Table 10
Amount of time for ecology topics in MEB curriculum, per grade

Grade	Time (Lesson)
9- Responsible individuals - liveable environment	16
10-Community ecology	30
11-Community and population ecology	32
12- Conservation and rehabilitation of environment	18
Total:	96

Table 11
Amount of time for ecology topics in IBDP curriculum, Topic 5

Topic 5:Ecology and evolution	Time(teaching hours)
5.1 Communities and ecosystems	5
5.2 The greenhouse effect	3
5.3 Populations	2
5.4 Evolution	3
5.5 Classification	3
Total:	10

Table 12

Amount of time for ecology topics in IBDP curriculum, Option G

Option G: Ecology and conservation	Time (teaching hours)
G1 Community ecology (SL,HL)	5
G2 Ecosystems and biomes (SL,HL)	4
G3 Impacts of humans on ecosystems (SL,HL)	6
G4 Conservation of biodiversity (HL)	3
G5 Population ecology(HL)	4
Total:	15(SL,HL) + 7(HL) = 22

Expertise for content development

Expertise depends on the quality of authorship and the sources used in writing the text.

The MEB, the IBDP and the IGCSE textbooks do not contain further information about the authors and their credentials. All of the MEB textbooks from 9th grade to 11th grade have the authors' name on the textbooks except 12th grade which was written by a committee.

The sources used in a textbook should reflect expert information. The editor, language specialist, program development specialist, measurement and evaluation specialist, guidance and counseling specialist and visual designer of textbooks are stated as names on each grade of the MEB textbooks. Similarly, the names of the picture researcher of the IBDP textbook are given. Information regarding photographs and illustrations are added to the IBDP and the IGCSE textbooks.

Accuracy of content

In this section, accuracy of content of the textbooks was analyzed according to correctness in historical and contemporary representation.

Content should be factual, free of mistakes and errors. Latin names were checked to see whether they were written correctly or not. One error was found in the IGCSE textbook, one error was found in the IBDP textbook in Option G. In the MEB textbooks, four errors for grade 10, two errors for grade 11 and one error for grade 12 were found and corrections were suggested below in Table 13. No error was found for grade 9 since Latin names were not used in natural issues and Atatürk’s opinions about nature and environment topics.

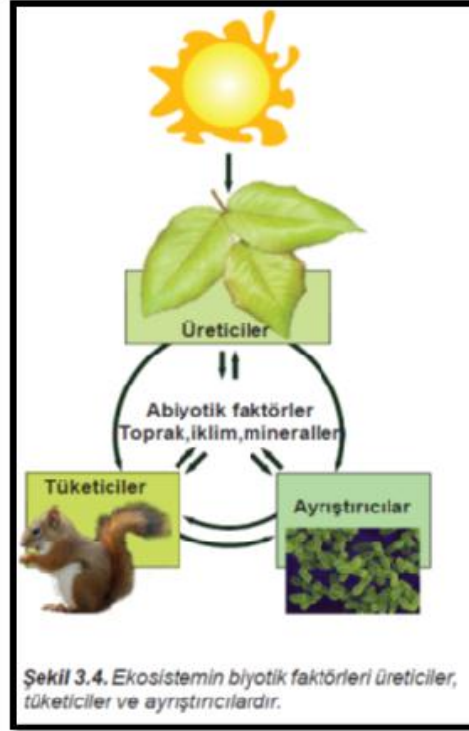
Table 13
Latin names in the selected textbooks

Latin names		
IGCSE	<i>Cholera vibrio</i> (p. 258)	<i>Vibrio cholerae</i>
IBDP- Option G	<i>Cactoblastic cactorum</i> (p. 577)	<i>Cactoblastis cactorum</i>
MEB Grade 10	<i>Araschnia levena</i> (p.185)	<i>Araschnia levana</i>
	<i>Ervinia coratovora</i> (p. 194)	<i>Erwinia carotovora</i>
	<i>Carassius gibellio</i> (p.225)	<i>Carassius gibelio</i>
	<i>Tlaspia caerulescens</i> (p.229)	<i>Thlaspi caerulescens</i>
MEB Grade 11	<i>Orobanche purpurea</i> (p.208)	<i>Orobanche purpurea</i>
	<i>Dreissena polimorpha</i> (p. 229)	<i>Dreissena polymorpha</i>
MEB Grade 12	<i>Rodolia cardinali</i> (p.228)	<i>Rodolia cardinalis</i>

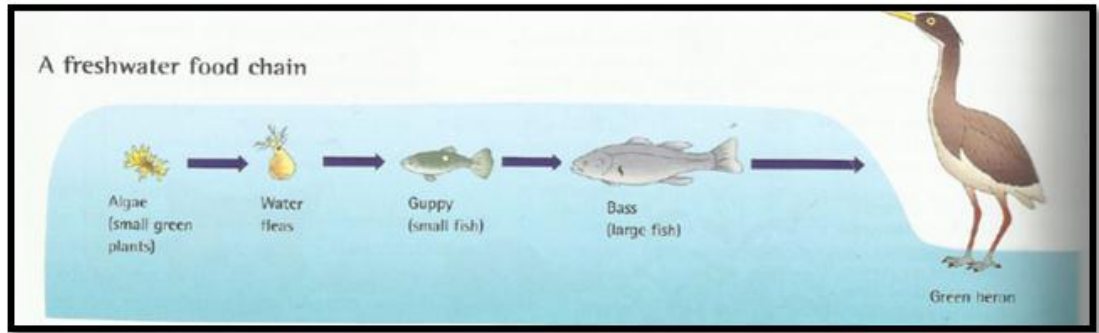
Visuals are important in teaching major concepts, and should not mislead students. For example, in the 10th grade MEB textbook biotic factors of ecosystem are represented by a figure. However, visuals of organisms show inconsistency in terms of proportion. Leaves, a squirrel and bacteria do not have magnification stated this may mislead students (Figure 1a). Other figures have the same proportion problem (Akkaya et al., 2011b, p.193, p. 200, p.201, p. 203, p. 204). Photomicrographs also are not given with their magnification and there is no information about which type of microscope was used.

The IBDP textbook has the same disproportion problem. Organisms do not represent their original size (Damon, McGonegal, Tosto & Ward, 2007, p.117).

Although the IGCSE textbook suffers the same disproportion problem, organisms in figures (Figure 1b) represent their original size better than the MEB textbook (Pickering, 2006, p.234, p. 235).



(a)



(b)

Figure 1. (a) Disproportion problem in grade 10 MEB textbook (b) Better representation of organisms in the IGCSE textbook

Currentness of content

Currentness of content depends on the context and edition of the textbook.

Ninth grade MEB textbook was accepted as a textbook by the Board of Education in 2008: the textbook analyzed was published in 2011 as a fourth edition. Tenth grade MEB textbook was accepted as a textbook by the Board of Education in 2009: the textbook analyzed was published in 2011 as the third edition. The eleventh grade MEB textbook was accepted as a textbook by the Board of Education in 2010: the textbook analyzed was published in 2011 as the second edition. Finally, 12th grade MEB textbook was accepted as a textbook in 2011, and published in 2011 as the first edition.

The IBDP textbook analyzed was first published in 2007.

The IGCSE textbook analyzed was published in 2006.

Six of the textbooks are current enough to show relevant visuals and photographs.

Authenticity of content

Authenticity of content is affected by real-life connections and the interdisciplinary treatment given in the textbooks. Accordingly, analyses were conducted for the MEB, the IBDP and the IGCSE textbooks in terms of real-life connections and interdisciplinary treatment. The results are presented as tables below.

Surprisingly, all of the textbooks present similar life connection about, CFCs, although CFCs are not used in new technological devices. In grade 9, the MEB textbook, “Chlorofluorocarbons (CFCs) are used in refrigerators, air conditioners and deodorants.” (Akkaya, Sağdıç, Albayrak, Öztürk & Cavak, 2011a, p. 212). Another life connection from the IBDP textbook: “An international agreement called the Montreal Protocol was adopted to phase out the use of CFCs in: refrigerator coolants, propellants for aerosols, material used to make foam packaging.” (Damon et al., 2007

p. 581). Another life connection from the IGCSE textbook “Most older refrigeration equipment contains freon, a chemical known as a chlorinated fluorocarbon or CFC. Each molecule of CFC can destroy over 100 000 molecules of the Earth’s protective ozone coating, leading to increased risk of sunburn, cataracts and skin cancer.” (Pickering, 2006, p. 264).

In Table 14, the sub-headings of ecology units are stated with the number of real- life connection included.

Table 14
Numbers of life connections in the MEB, IBDP and IGCSE textbooks

				Real life connections	Total
MEB	Grade 9	I.	Environmental issues	26	27
		I.	The perceptivity of Atatürk about Nature and Environment 1	1	
	Grade 10	I.	Ecosystem structure	16	28
		II.	Energy flow and cycles of matter in ecosystems	6	
		III.	Ecosystem services and sustainability	6	
	Grade 11	I.	Community ecology	3	20
		II.	Population ecology	7	
		III.	Biomes	10	
	Grade 12	I.	The importance of sustainability of matter and food sources	8	24
		II.	Conservation of biodiversity	9	
		III.	Rehabilitation of environment and forming environmental awareness	7	
	IBDP	Topic 5	5.1	Communities and ecosystems	0
5.2			The greenhouse effect	5	
5.3			Populations	1	
Option G		G1	Community ecology	3	17
		G2	Ecosystems and biomes	3	
		G3	Impacts of humans on ecosystems	8	
		G4	Conservation of biodiversity	3	
		G5	Population ecology	0	
IGCSE					7

Grade 9 MEB textbook represents interdisciplinary treatment in the areas of Turkish language and literature, geography, chemistry, art and use of technology. At the beginning of the unit, “Memleket İsterim” poem is presented and the directions are that the students are to conduct an investigation about their natural system of environment and the natural life where students live. Then, students are asked to discuss past, present, and future of the environment based upon the poem. A suggestion is given that students may integrate their understandings from this unit with the geography topic Environment and Society.

In addition, the activities of the textbooks provide opportunities for students to improve their skills on art and use of technology. For example, students are asked to research on the internet how to prevent water pollution, and present their finding as pictures, text, and cartoon or to write a newspaper article. In this activity, students may improve their skills about art and use of effective language. Grade 10 MEB textbook represents interdisciplinary treatment in the areas of Turkish language and literature, use of technology, and art. Similar to the 9th grade textbook, the 10th grade ecology unit starts with a connection to Turkish literature. The beauty of the environment is told by a section from author Yaşar Kemal. Grade 11 MEB textbook has connections to mathematics, and the use of Turkish language with activities. Finally, 12th grade MEB textbook unit starts with a connection to chemistry, regarding bioplastics. The unit includes activities related to the use of technology and the use of the Turkish language. In addition, the MEB textbooks mentioned connected contain historical events.

Topic 5 of the IBDP textbook contains graphs which indicate the mathematical connections of the topic. Historical events are also mentioned in the topic that is

another interdisciplinary reference. Option G of IBDP textbook has a formula to calculate the production in the ecosystem; this formula represents mathematic connection of topic.

The IGCSE textbook ecology unit also contains a few interdisciplinary references. As in the IBDP textbook, graphs are connection to mathematics and concepts such as acid rain are a connection to chemistry.

Multicultural representation

Multicultural representations of the textbooks were analyzed according to two dimensions: fairness and advocacy. The MEB, the IBDP and the IGCSE textbooks were analyzed and explored. Because of the nature of ecology, gender, age, disability, national origin and religious concepts find no place in the textbooks. Although the MEB textbooks mainly focus on Turkey, all textbooks give international examples.

Humanity and compassion

Humanity and compassion of the textbook depends on the inclusion of compassion and the exclusion of inhumanity. The six textbooks were analyzed and no inhumane treatment or sexism appeared throughout the six selected textbooks.

Presentation

In this section, the analysis results of the ecology units of the six textbooks were presented from the seven perspectives given by the FLDOE: (i) comprehensiveness of student and teacher resources, (ii) alignment of instructional component, (iii)

organization of instructional materials, (iv) logical organization, (v) readability of instructional materials, (vi) pacing of content, (vii) ease of materials use.

Comprehensiveness of students and teacher resources

Resources must support teachers if they are available. In this section, to analyze textbooks is impossible, since there no teacher resources are provided for the selected MEB and IBDP textbooks. Student resources were analyzed according to other perspectives and the findings are presented under other subheadings.

The author of the IGCSE textbook has published a teacher's resource kit in 2011. The analysis results were discussed under the sub-heading of alignment of instructional components.

Alignment of instructional components

Instructional materials, student and teacher materials must align with each other and the curriculum. Analysis showed that there is no teacher material for the selected MEB and IBDP textbooks. Thus, there is no result reported in this section for these textbooks.

The author of the IGCSE textbook published a revision guide in 2009 and added a teacher's resource kit in 2011. This kit includes a CD. In the teacher's resource kit, practicals, worksheets, trial exam papers, animations, and PowerPoints are available. In the revision guide: Ecology and ecosystems, the cycling of nutrients, human impact on the environment, farming and food production and conservation are included as topics parallel to the student textbook.

Organization of instructional materials

In this section, textbooks were analyzed according to access to content, visible structure and format, and logical organization of content and activities.

The MEB, the IBDP and the IGCSE textbooks present a table of contents, index, and introductions. Each textbook has visual cues to signal better organization and illustrations for better visual structure. While the IBDP and the IGCSE textbook give the goals of the units, the MEB textbooks do not present any goals or objectives. While the MEB textbooks present a bibliography and a glossary at the end of the textbooks, the IBDP and the IGCSE textbooks present neither glossary nor bibliography. In Table 15 some features that help in searching and locating information is presented for the MEB, the IBDP and the IGCSE textbooks.

Table 15
Some features for access to content of the MEB, IBDP and IGCSE textbooks

	MEB Grade 9	MEB Grade 10	MEB Grade 11	MEB Grade 12	IBDP	IGCSE
Table of contents	+	+	+	+	+	+
Index	+	+	+	+	+	+
Goals/Objectives	-	-	-	-	+	+
Bibliography	+	+	+	+	-	-
Glossaries	+	+	+	+	-	-
Introductions	+	+	+	+	+	+
Visual cues	+	+	+	+	+	+
Illustrations	+	+	+	+	+	+

The MEB textbooks give more detail in the headings and sub-headings in the table of contents that makes it easier to find information within the units. Furthermore, except grade 12 textbook, all of the MEB textbooks tables of contents' contain a picture for attractiveness. The IBDP textbook gives headings in the table of contents but gives less information about sub-headings which makes it harder to search for information. Pictures or figures are not used in the table of contents. Similar to the IBDP textbook,

the IGCSE textbook gives headings in the table of contents, but gives less information about sub-headings and does not have any picture or figure. In Figure 2 the table of contents of the MEB textbook is presented.

III. ÜNİTE	
Komünite ve Popülasyon Ekolojisi	
I-Komünite Ekolojisi.....	202
A. Komünitenin Yapısı ve Komüniteye Etki Eden Faktörler.....	
Faktörler.....	203
B. Komünitelerde Rekabet ve Av-Avcı İlişkisi.....	204
C. Komünitede Simbiyotik İlişkiler.....	207
1. Mutualizm.....	207
2. Kommensalizm.....	207
3. Parazitizm.....	208
D. Süksesyon.....	210
1. Birincil Süksesyon.....	210
2. İkincil Süksesyon.....	211
Konu Sonu Değerlendirme.....	212
II-Popülasyon Ekolojisi.....	214
A. Popülasyon Dinamiği.....	
1. Popülasyon Yoğunluğu.....	215
2. Popülasyon Büyüklüğü.....	216
3. Popülasyon Dağılımı.....	218
4. Popülasyonda Yaş Dağılımı.....	218
B. Popülasyondaki Aşırı Büyümenin Olası Sonuçları.....	220
C. Nesli Tehlikede Olan Türler.....	222
Konu Sonu Değerlendirme.....	225
III- Biyomlar.....	228
A. Bitki ve Hayvanların Yeryüzündeki Dağılımını Etkileyen Faktörler.....	
1. Türün Dağılımı.....	230
2. Davranış ve Habitat Seçimi.....	230
3. Biyotik Faktörler.....	230
4. Abiyotik Faktörler.....	230
B. Biyom ve Ekosistem Arasındaki İlişki.....	231
C. Dünyadaki Başlıca Karasal ve Sucul Biyomların Özellikleri.....	
1. Karasal Biyomlar.....	232
2. Sucul Biyomlar.....	238



Figure 2. The MEB textbook grade 11 table of contents

Visual cues in textbooks are helpful to signal organization and content. All of the MEB textbook visuals are numbered. This makes it easy to look at related visuals within the text. Visuals of the IBDP and the IGCSE textbook are not numbered.

While the IGCSE textbook signals the more difficult questions with yellow color code (Figure 3), the MEB and the IBDP textbooks do not differentiate questions with color code (Pickering, 2006, p.249). All the MEB textbooks, the IGCSE textbook and the IBDP textbook have color coding for each of units.

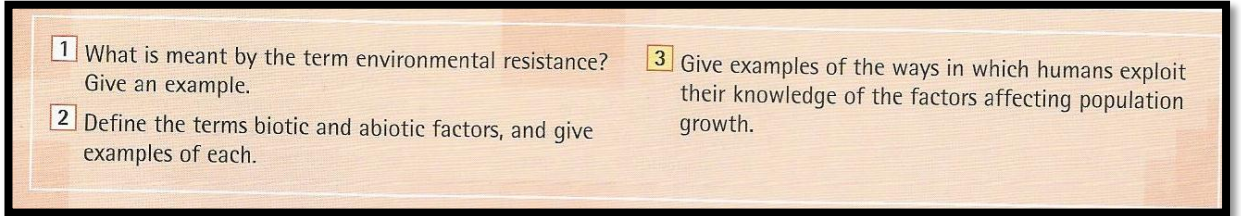


Figure 3. Color code of questions for the IGCSE textbook

The MEB textbooks have text boxes under the sub-headings of “Let’s think and research”, “Let’s research and learn”, ”Let’s think and discuss”, “Attention!”, “Do you know?” and these boxes are introduced at the beginning of the textbook at the section of “Let’s know our textbook”.



Figure 4. Examples of boxes from grade 11 MEB textbook

Similar to the MEB textbook, the IBDP textbook presents information boxes. They are introduced at the beginning of the textbook, in the introduction section. The information boxes are about Theory of Knowledge, interesting information, key facts, global perspective, examiner's hints, and Heinemann website.

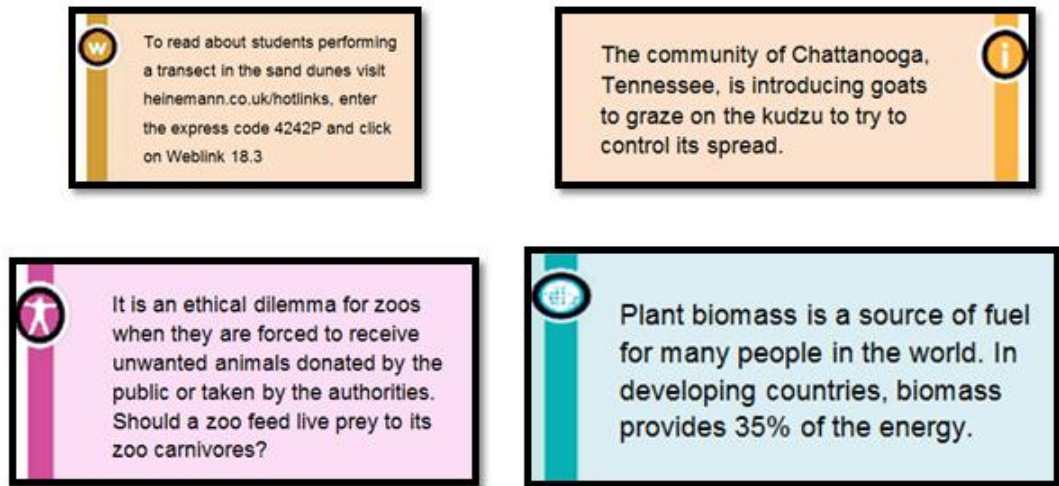


Figure 5. Information boxes of the IBDP textbook

The IGCSE textbook does not have text boxes as in the MEB or the IBDP textbooks. The IGCSE presents the example of bite-size “chunking” (Pickering, 2006, p.231). Terms are defined outside of the text and their importance is emphasized with bold treatment of font style. Similarly, as in the terms, some information is given as boxes.

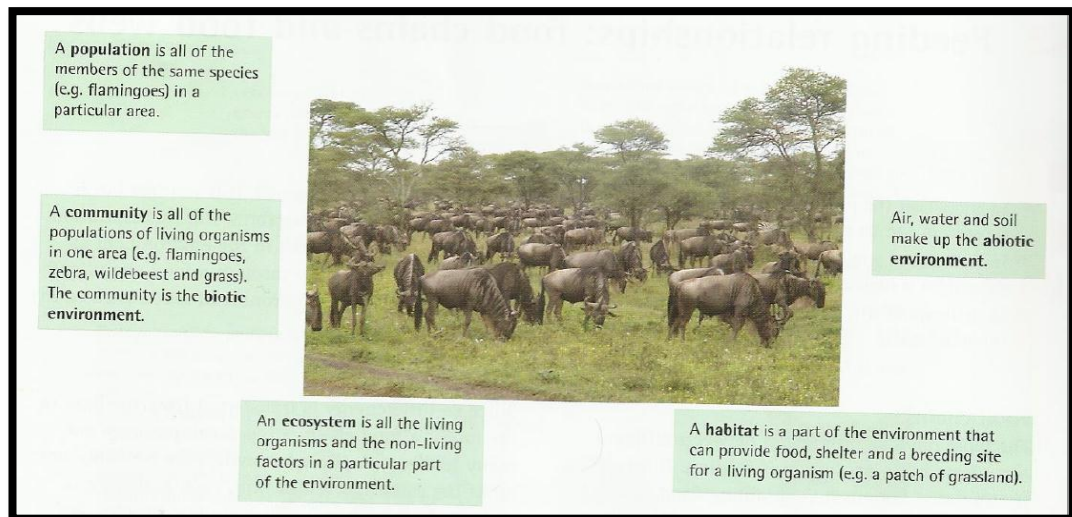


Figure 6. Examples of chunking from the IGCSE textbook

Page numbers of each of six textbooks are given consistently. In Table 16, the pages devoted for ecology units for each of six textbooks are presented.

Table 16

Textbook	Total number of pages	Number of pages allocated to ecology topics	Percent weights of ecology topics over whole textbook
MEB Grade 9	276	43	15.6%
MEB Grade 10	264	72	27.3%
MEB Grade 11	274	51	18.6%
MEB Grade 12	264	24	9.1%
IGCSE	286	49	17.13%
IBDP	IBDP Topic 5	22	3.1%
	IBDP Option G	49	6.9%

Weight of the ecology topics in the six biology textbooks

Results from analyses of visual structure of six textbooks are presented in Table 17.

Table 17
Visual structure of the six textbooks

		MEB grade 9	MEB grade 10	MEB grade 11	MEB grade 12	IBDP	IGCSE
Font style	Headings	Arial	Arial	Arial	Arial	Times New Roman	Times New Roman
	Subheadings	Arial	Arial	Arial	Arial	Times New Roman	Times New Roman
	Visual explanations	Arial	Arial	Arial	Arial	Times New Roman	Times New Roman
	Text	Arial	Arial	Arial	Arial	Times New Roman	Times New Roman
	Box	Arial	Arial	Arial	Arial	Arial	Times New Roman
Color	Headings	Dark Blue	Red	Red	Red		Black
	Subheadings	Orange	Blue	Dark Blue	Black		Black
	Visual explanations	Black	Black	Black	Black	Black	Black
	Text	Black	Black	Black	Black	Black	Black
	Box	Black	Black	Black	Black	Black	Black
Treatment	Headings	11/Bold	13/Bold	14/ Bold	13.5/Bold	Bold	Bold
	Subheadings	11/Bold	11/Bold	12/Bold	12.5/Bold	Bold	Bold
	Visual explanations	9.5/Bold Italic	8.5/ Italic	9/Italic	8.5/Bold Italic/-	-	-
	Text	9.5/-	10/-	11/-	9.5/-	9/-	11/-
	Box	9.5/-	10/-	10/-	8.5/ Italic	8/-	8/-

At the end of each section and each unit of the MEB textbooks, questions are given for students to practice and for assessment purposes. Related activities and experiments are offered for students. The IBDP textbook does not offer activities and experiments for students. Questions are given at the end of the unit. The IGCSE textbook offers questions throughout the topic. Table 18 shows the number of boxes in the MEB textbooks. Table 19 shows the number of boxes in the IBDP textbook.

Table 18
Boxes of the MEB textbooks

Types of boxes	Number			
	Grade 9	Grade 10	Grade 11	Grade 12
Do you know?	6	14	5	6
Let's think and research	3	13	7	-

Table 18 (Cont'd)
Boxes of the MEB textbooks

Let's think and discuss	2	-	-	-
Let's research and learn	-	-	-	8
Attention	-		2	
Text for reading	2	1	1	3
Other activities	7	6	2	2
Assessment parts	2	5	4	1

Table 19
Boxes of the IBDP textbook

Types of boxes	Number	
	Topic 5	Option G
Theory of Knowledge	2	6
Interesting information	2	3
Key facts	1	1
Global perspective	1	10
Examiner's hint	5	1
Website link	2	27
Exercise	3	6

Logical organization

The MEB textbooks follow the spiral curriculum of MEB. Ecology-related topics start from grade 9 and go to grade 12. In each grade, the complexity level of content increases but grade 12 is relatively easier than the 10th and 11th grade topics. Flow of topics for the six selected textbook is presented in Table 20, 21, 22, 23.

Table 20
Order of ecology-related units in MEB textbook by sub-heading

Grade 9	Grade 10	Grade 11	Grade 12
I. Environmental Issues	I. Ecosystem structure	I. Community ecology	A. The importance of sustainability of matter and food sources
A. Air pollution	A. Ecology and importance	A. Community structure and the factors effecting community	1. Soil
1. Greenhouse effect and global warming	B. Ecology interactions with other disciplines	B. Competition and prey-predator relationship	2. Water
2. Carbon footprint	C. Major concepts in ecology	C. Simbiotic relations	3. Meadow
3. Ozone pollution	D. Factors affecting living organisms	1. Mutualism	4. Forest
4. Acid rains	1. Abiotic factors	2. Commensalism	B. Conservation of biodiversity
B. Water pollution	a. Light	3. Parazitism	1. Conservation of terrestrial and aquatic biodiversity and precautionary discipline on sustainability
C. Soil pollution	b. Temperature	a. Endoparazit	2. The importance of conservation of sources used in agriculture and stockbreeding
D. Noise pollution	c. Climate	b. Egzoparazit	
E. Light pollution	d. Soil and minerals	D. Succesion	
F. Food pollution	e. Water	1. Primary succesion	
G. Radiation pollution	f. Environment's pH	2. Secondary succesion	
H. Erosion	2. Biotic factors		
I. Wildlife issues	a. Producers		
J. Forest fire	b. Consumers		
K. Ecological footprint	c. Detirivores		

Table 20 (Cont'd)

Order of ecology-related units in MEB textbook by sub-heading

II. Atatürk's opinions about nature and environment	II. Energy flow and cycles of matter in ecosystems A. Energy and matter flow B. Food pyramid, food web and biomass pyramid C. Cycles of matter 1. Water cycle 2. Carbon cycle 3. Nitrogen cycle III. Ecosystem services and sustainability A. Ecosystem services B. Sustainability 1. Can be constructed sustainable artificial ecosystem? 2. Effects of population on sustainability 3. Effects of cities on sustainability 4. Effects of technological development on sustainability 5. Effects of agriculture on sustainability C. Can be fixed decomposed ecosystem?	II. Population ecology A. Population dynamic 1. Population density 2. Population size Carrying capacity III. Biomes	C. Rehabilitation of environment and environmental awareness 1. Environmental ethic, relationship between conservation of environment and sustainable development
--	---	--	---

Table 21

Order of Topic 5 in IBDP textbook by sub-heading

IBDP Topic 5		
5.1 communities and ecosystems Autotrophs and heterotrophs Detritivores and saprotrophs Food chains Food webs Trophic level Constructing a food web Energy-the importance of life Energy flow Energy loss Pyramid and energy Energy and nutrients Decomposers	5.2 the greenhouse effect The carbon cycle Changes in atmospheric CO ₂ level The enhanced greenhouse effect The greenhouse gases The precautionary principle Evaluating precautionary principle Prevention is better than cure Human impact on arctic ecosystems	5.3 populations Population dynamics Population growth curve Causes of exponential phase Causes of the transitional phase Causes of the plateau phase Carrying capacity

Table 22

Order of Option G in the IBDP textbook by sub-heading

IBDP Option G : Ecology and conservation			
G.1 community ecology Factors affecting distribution of plant species Temperature and water Light	G.2 Ecosystems and biomes Energy flow through the ecosystem Gross production, net production and biomass	G.3 Impact of humans on ecosystems Simpson diversity index Reasons for conservation of biodiversity Economic reasons	G.4 Conservation of biodiversity Indicator species and biotic indices Biotic index

Table 22 (Cont'd)

Order of Option G in IBDP textbook by sub-heading

Soil pH	Calculating gross	Ecological reasons	Factors contributing to
Salinity	production and net	Ethical reasons	extinction
Mineral nutrients	production	Aesthetic reasons	Features of nature
Factors affecting	Constructing a pyramid	Argument against	reserves which promote
distribution of animal	of energy	conservation	biodiversity
species	Pyramids of biomass	Introduction of alien	Determination of size
Temperature	Difficulties of classifying	species	Edge effect
Water	organisms into trophic	Kudzu	Corridors
Breeding sites	levels	Zebra mussels	Management of
Food supply	Primary and secondary	Pricky pear	conservation areas
Territory	succession	Impact of alien species on	Restoration
Random sampling	Species diversity and	ecosystems	Recovery of threatened
The quadrat method	production in a primary	Interspecific competition	species
The transect	succession	Predation species	Removed introduces
The niche concept	Fore dune	extinction	species
Spatial habitat feeding	Yellow dune	Biological control	Legal protection against
activities	Grey dune	Purple loosestrife	development or pollution
Interactions with other	Mature dune	Red fire ants	Funding and prioritizing
species	Living organisms change	Biomagnification	<i>In situ</i> conservation
Competition	the abiotic environment	Causes of	methods
Herbivore	Organic matter increases	biomagnification	<i>Ex situ</i> conservation
Predation	Soil gets deeper	Consequences of	methods
Parasitism	Soil erosion reduces	biomagnification	Captive breeding
Mutualism	Soil structure improves	Effects of UV radiation	Botanical gardens
Competitive exclusion	Mineral recycling	Non-lethal skin cancer	Seed banks
Fundamental niche	increases	Lethal skin cancer	G.5 Population ecology
versus realized niche	Biosphere and biomes	Mutation of DNA	Distinguishing r-strategy
Biomass	Distribution of biomes	Sunburn cataracts	from k-strategy
Measuring biomass at	Tundra	Reduced biological	Environmental
each trophic level	Coniferous forest	productivity	conditions of r-strategies
	Temperata forest	CFC and ozone layer	and k-strategies
	Desert		Ecological disruption
	Tropical forest		Using the capture-mark-
			release-recapture
			Estimating the size of
			commercial fish stocks
			Maximum sustainable
			yield
			International measures to
			promote conservation of
			fish

Table 23

Order of ecology topics in IGCSE textbook by sub-heading

Section 4: Relationships of organisms with one another and with their environment

- 4.1 Ecology and ecosystems
- 4.2 Feeding and relationships: food chains and food webs
- 4.3 Feeding relationships: pyramids of number, biomass and energy
- 4.4 Decay is a natural process
- 4.5 The carbon cycle
- 4.6 The nitrogen cycle
- 4.7 Water recycled too!
- 4.8 Factors affecting population size
- 4.9 Human population growth
- 4.10 Human impacts on the environment: pollution of atmosphere
- 4.11 Pollution of water
- 4.12 Preventing disease: safe water
- 4.13 Humans, agriculture and conservation

Table 23 (Cont'd)

Order of ecology topics in IGCSE textbook by sub-heading

4.14 Pollution of the land

4.15 Disposal of solid waste

4.16 Humans may have a positive effect on the environment: conservation

4.17 Human management of ecosystems: fish farming and horticulture

4.18 Helping the environment: fuel from fermentation

4.19 Humans can control disease: using fungi to produce antibiotics

4.20 Controlling disease by understanding vectors

Readability of instructional materials

The readability of instructional materials was determined by language style, visual features and typographical presentation features.

Readability of the six selected textbooks was calculated. The results are presented in Appendix D.

The reading ease of grade 9 MEB textbook is calculated as 53.07. This readability level is moderate. The reading ease of grade 10 MEB textbook is calculated as 52.31, again moderate. Differently from grades 9 and 10, the reading ease of grade 11 MEB textbook is calculated as 48.70 and the readability level is difficult. Finally, similar to grades 9 and 11, level of readability of grade 12 MEB textbook is moderate and readability ease is calculated as 52.07.

The readability ease of Topic 5 of the IBDP textbook is calculated as 60.17, moderate. Option G part of the IBDP textbook presents 71.67 readability ease and level of readability is easy. Similar to Option G part of IBDP textbook, the IGCSE textbook presents 72.7 readability ease, and readability level is easy.

Visuals of the six selected textbooks were counted and classified. The results of analysis are presented below in Table 24.

Table 24
Classified visuals of the six textbooks

	MEB	MEB	MEB	MEB	IGCSE	IBDP	
	Grade 9	Grade 10	Grade 11	Grade 12		Topic 5	Option G
Photographs	22	35	29	16	7	19	13
Figure	2	14	4		35	5	16
Table					1	2	6
Graphics		1	5		5	2	
Schema		1					
Total	24	51	38	16	48	28	35

When the MEB textbooks are considered as one textbook it is seen that they have the most number of visuals used to teach ecology. The IBDP textbook has a total of 63 visuals to represent ecological concepts, and the IGCSE textbook has only 48, which is the lowest number among the textbooks.

Pacing of content

Pacing of content must consider the cognitive load. In this section, analyses were conducted according to cognitive load.

The MEB and the IBDP textbooks present different types of information boxes, but the IGCSE textbook presents blocks of information and bite-size chunks. The IGCSE textbook explains terms in these sections, so the pace of textbook is faster than the MEB and the IBDP textbooks.

Ease of materials use

In this section, the six selected textbooks were analyzed in terms of warranty, practicality of use, durability and cost. The analysis results are reported below.

None of these six textbooks has a hard cover which is an advantage for weight. MEB Grade 9 textbook has 276 pages, grade 10 has 264 pages, grade 11 has 274, and grade 12 has 264 pages. Similar to the MEB textbooks, the IGCSE textbook has 286

pages which is practical for students to take home. However, the IBDP textbook has 710 pages and it is relatively difficult for students to take home.

According to analysis, only the MEB textbooks are available for online access. It is not possible to find online versions of the IBDP and the IGCSE textbooks. Moreover, while the IBDP textbook has links to connect the Heinemann website for activities and further information, the MEB and the IGCSE textbooks do not have an internet link.

The MEB textbooks are distributed to state schools free of charge in Turkey.

However, their cost is announced on the MEB website of Board of Education. The price is 6.50 TL for grade 9, 5.75 TL for grade 10, 6.50 TL for grade 11 textbook. No information is given for grade 12 MEB textbook. The IBDP textbook is sold for 167.70 TL and the IGCSE textbook for 82, 30 TL on a website. Therefore, the most expensive textbook is the IBDP textbook. The MEB textbooks are the lowest cost textbook.

Learning

In this section, the results of the analysis of the ecology units of the six selected textbooks were presented from seven perspectives of by the FLDOE: (i) motivational strategies, (ii) teaching a few “Big Ideas”, (iii) explicit instruction, (iv) guidance and support, (v) active participation of students, (vi) targeted instructional assessment strategies, (vii) instructional strategies and assessment techniques.

Motivational strategies

Instructional materials must provide motivation for learners. Appearance, positive expectations and feedback are the features included in motivation. Thus, in this section analyses were conducted according to all these features and the results are presented.

When analyzing the language style of the six selected textbooks, the most friendly approach is found in the four MEB textbooks. The language of the MEB textbook is like someone talking about a topic in face to face communication. For example, in grade 11 textbook the unit starts with this explanation: “When you have a trip in forestland or in a park, try to observe the environment. During this observation, you can see trees, birds, bugs, spiders and the bushes that grown under the shadow of trees. These living organisms have interactions with each other and with their environment. In this chapter, you will learn the structure of community, the factors that affect the communities, interspecific and intraspecific competitions, the symbiosis and primary and secondary succession by investigating the different interactions between organisms.” (Sağdıç, Albayrak, Öztürk & Cavak, 2011, p. 203). Moreover, life connections help to support the friendly approach of textbooks.

Unlike the MEB textbook, the language style of the IBDP textbook is more mechanical. It is more scientific, rather than the friendly approach of the MEB textbook.

However, there are still a few friendly language examples. Fewer life connections support the language of the textbook, for example, “If you think about the vast majority of the foods you eat, you can trace the energy they contain to sunlight. Milk,

for example, gets its energy from the cow which produced it.” (Damon et al., 2007 p. 118).

The IGCSE textbook has the most scientific language style. Analysis reveals that there are no life connections in the IGCSE textbook. It directly explains terms to students.

Group projects, presentations, collaborative assignments are the factors that help create a learning climate. When the six selected textbooks were analyzed, it was discovered that the four MEB textbooks offer a high variety of activities for students that include experiments, assignments, trips, designs, and projects. For example, in Grade 9, the MEB textbook recycling project is offered for students. They are asked to study within groups and to write a report about their findings. Then, students are expected to present their results to their classmates. As a result of this project, poster designing is suggested for students (Akkaya et al., 2011a, p. 236). In these activities, students share their experiences, write a report, and ask questions to their family members. These activities support the learning of students and can motivate them (FLDOE, 2008).

The MEB textbooks offer students personal connections which may be effective in improving their learning. They provide different varieties of questions to students given at the end of each section. This is an opportunity for students to self-assessment. The IGCSE textbook also offers questions throughout the unit. However, it gives questions at the end of the unit and in poor variety.

Only the IBDP textbook has a technology connection. The link to the Heinemann website is given for students. Within the website, there are animations, further information, data calculators, statistics and online experiments for use by students.

Teaching a few “Big Ideas”

It is expected that an instructional material should teach a few “Big ideas”. Big ideas, major themes and concepts provide students completeness and focus. For example, population and community are big ideas. Environmental Education and Training Partnership (2002) gives big ideas. These concepts were combined and the analysis of the six selected textbooks was done according to these features. The results are presented in Table 25.

According to the analysis, the MEB textbooks covered 16 ecological concepts out of 20 while the IBDP and the IGCSE textbooks covered 12 concepts out of 20.

Environmental ethic is presented in 12th grade MEB textbook, but not in IBDP or IGCSE textbooks. Surprisingly, while the MEB and the IBDP textbooks discussed the concept of succession, the IGCSE textbook does not cover it. According to the criteria, the concept of homeostasis should be taught in ecology units but all of the textbooks cover the concept of homeostasis in other topics. And while the MEB and the IGCSE textbooks present water, carbon and nitrogen cycles, the IBDP textbook surprisingly presents only the carbon cycle.

Table 25
Comparison of big ideas of the textbooks

Major concepts or “big ideas”	MEB	IBDP	IGCSE
• laws of thermodynamics	+	+	+
• basic principles of ecology	+	+	+
• carrying capacity	+	+	+
• energetics	+	+	+
• least-cost end-use analysis	+	-	-
• how to live well in a place	+	+	+
• limits of technology	-	-	-
• appropriate scale	-	-	-

Table 25 (Cont'd)
Comparison of big ideas of textbooks

• sustainable agriculture and forestry	+	-	+
• steady-state economics	-	-	-
• environmental ethics	+	-	-
• individuals and populations	+	+	+
• interactions and interdependence	+	+	-
• environmental influences and limiting factors	+	+	+
• energy flow and nutrient cycling	+	-	+
• community and ecosystem concepts	+	+	+
• homeostasis	-	-	-
• succession	+	+	
• humans as members of ecosystems	+	+	+
• ecological implication of human activities and communities	+	+	+
Total	16	12	12

Explicit instruction

Explicit instruction means the clarity of directions and explanations, and the exclusion of ambiguity. Therefore, in this section, these two features are analyzed.

In the MEB textbooks, ecology units start with an introduction and continue with core topics. This makes transitions within the textbook smooth enough to follow a change of topic. Unlike the MEB textbooks, the IBDP and the IGCSE textbooks give the objectives of topics at the beginning of each section. This helps students to follow the topics step by step. The instructions given in MEB, IBDP and IGCSE textbooks are clear. The activities and assignments that are given in the MEB textbooks are explained in an understandable way. Students have clear directions to achieve assignments and they can easily follow the steps of the activities. The IBDP and the

IGCSE textbooks do not offer activities and assignments for students, so it is not possible to talk about the explicitly of instructions for activities and assignments.

The MEB textbooks and the IBDP textbook have an introduction at the start of each textbook. The information in the introduction includes how to use the textbook and is clearly stated. The information boxes, the meaning of logos, safety rules to conduct activities are also explained to students.

Advance organizers are part of the explicit instruction. The MEB textbooks have different types of boxes throughout the units as mentioned in the presentation part and the IBDP textbook also has information boxes.

Guidance and support

Instructional materials should help students to be independent thinkers and learners, and should give effective guidance and support at the right level. In this section, the analysis of the six selected textbook consider the adaptability and level of guidance and support.

Advanced students can learn from lectures but scaffolding is required for average students. Scaffolding is provided by variety of activities. All six textbooks were analyzed and it was seen that only the MEB textbooks offer different types of activities to students. The types of activities offered are: experiments, assignments, trips, designs, and projects. Goals of activities and assignments are given at the beginning of each which is important in guidance and support.

Only the IBDP textbook presents a type of information box called an examiner's hint. In these boxes, students learn how to answer exam questions, they serve as a

guide to solving questions. While five examiner’s hint boxes are given in Topic 5, only one is given in Option G. In Topic 5, for example, the hint given to describing the correct answer is: “Although primary consumers are plant eaters and secondary consumers eat flesh, the terms herbivore or carnivore should be used only to describe their diet, not to describe their trophic levels.” (Damon et al., 2007, p. 116).

While the MEB textbooks give names of terms in bold the IBDP textbook gives the names of terms in italics. The IGCSE textbook defines some terms in small boxes, and all names of terms are given in bold.

Analogies are helpful for students to develop better thinking skills when they are used effectively. The six selected textbooks were analyzed and analogies were found. While the IGCSE textbook does not make use of analogies in the instructions, both the MEB textbooks and the IBDP textbook do. For example, an analogy is used to explain the working pattern of ecosystems: “Scientists who are studying ecosystems, are concerned about how ecosystems work rather than individual organism or communities. This working pattern can be likened to a factory that produces regularly.”(Akkaya et al., 2011b, p.178). Another analogy example from the IBDP textbook Option G, “Ozone is like a protective sunscreen for the planet.”(Damon et al., 2007, p.580).

The number of analogies according to the textbooks is listed in Table 26.

Table 26
Number of analogies of six textbooks

		Number of analogies
MEB	Grade 9	5
	Grade 10	10
	Grade 11	1
	Grade 12	1
IBDP	Topic 5	2
	Option G	4
IGCSE		0

Active participation of students

Student responses and assignments determine the active participation of students.

Instructional material should help students in their learning process, in terms of physical and mental engagement and activities help this. Of the books analyzed, only the MEB textbooks provided student activities. The type and number of activities are presented in Table 27.

Table 27
Lists of activities that are offered in the MEB textbooks

Activities		
Grade 9	✓ <i>Experiment:</i> How do acid rains affect plants? (p. 214)	
	✓ <i>Poster:</i> Air pollution (p. 215)	
	✓ <i>Prepare newspaper:</i> How can water pollution be prevented? (p. 218)	
	✓ <i>Presentation:</i> The importance of sound in our lives (p. 222)	
	✓ <i>Trip:</i> What are the things to consider about environment lightning? (p. 224)	
	✓ <i>Presentation:</i> What are the dangers of the food we consume? (p. 226)	
	✓ <i>Project:</i> Recycling (p. 236)	
	<hr/>	
	Grade 10	✓ <i>Realize what is learned:</i> Ecosystem and life (p. 174)
		✓ <i>Model constructing:</i> Can we construct a natural ecosystem? (p. 178)
✓ <i>Project:</i> Ecosystem we lived (p.180)		
✓ <i>Learning:</i> Food web (p. 204)		
✓ <i>Interpretation:</i> Bioaccumulation (p.206)		
✓ <i>Poster designing:</i> Cycles of matter (p. 214)		
<hr/>		
Grade 11	✓ <i>Activity:</i> Prey and predator relationship (p.206)	
	✓ <i>Activity:</i> Endangered species (p.224)	
<hr/>		
Grade 12	✓ <i>Activity:</i> Avlan Lake (p. 233)	
	✓ <i>Project:</i> Rehabilitation of environment that we are living in (p. 234)	
	<hr/>	

Targeted instructional and assessment strategies

Learning outcomes stated in curriculum requirements should be taught, and instructional materials should include instructional and assessment strategies to assist in teaching.

If alignment and completeness of strategies are available in instructional material, it is possible to teach the learning outcomes targeted in the curriculum. The analysis results of the MEB, the IBDP and the IGCSE textbooks regarding the alignment of strategies and completeness of strategies are given in this section.

The MEB textbooks, according to the curriculum, deliver ecology topics with 30 objectives. These objectives are mainly in the comprehension level of Bloom's Taxonomy (53.33%).

The IBDP textbook Topic 5 section delivers ecology topics with 25 objectives, mostly at the knowledge level (40%). The IBDP textbook Option G section delivers ecology topics with 44 objectives, mostly at the analysis level (43.19%). The IGCSE textbook delivers ecology topics in 24 objectives, again mostly at the knowledge level.

The objectives for all these texts, according to Bloom's Taxonomy levels, are presented in Figures 7, 8, 9.

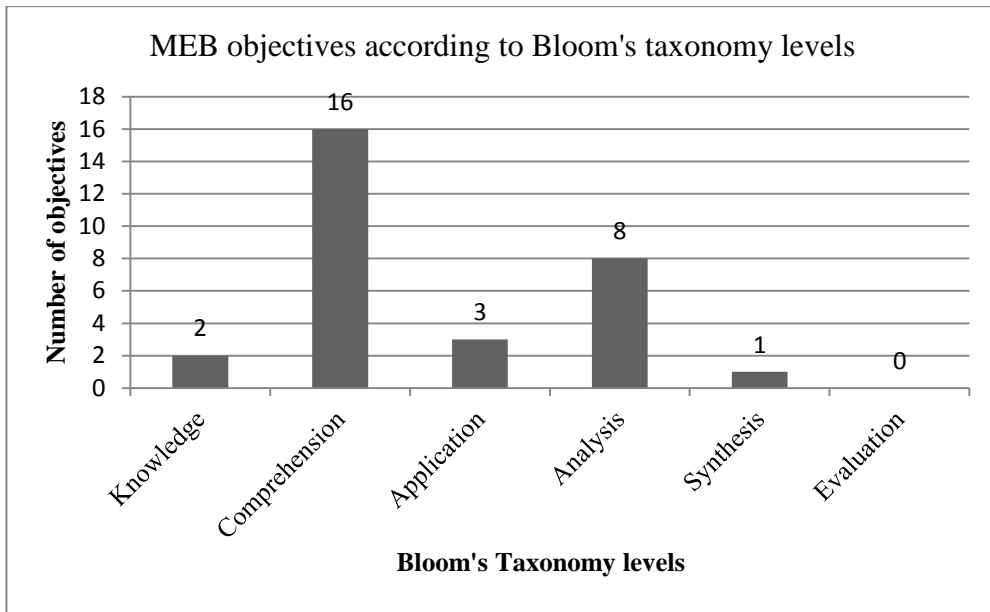


Figure 7. MEB objectives according to Bloom's Taxonomy levels

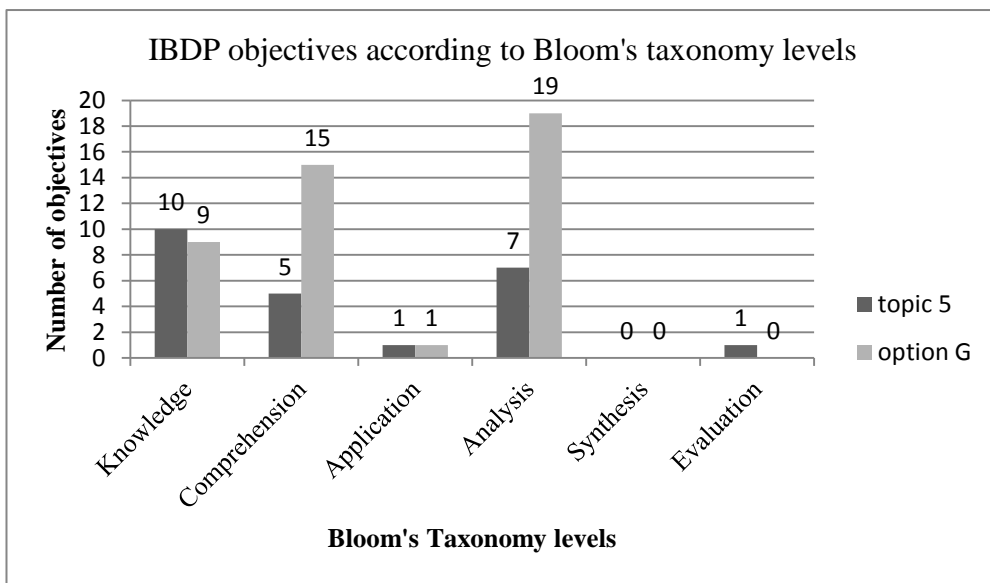


Figure 8. IBDP objectives according to Bloom's Taxonomy levels

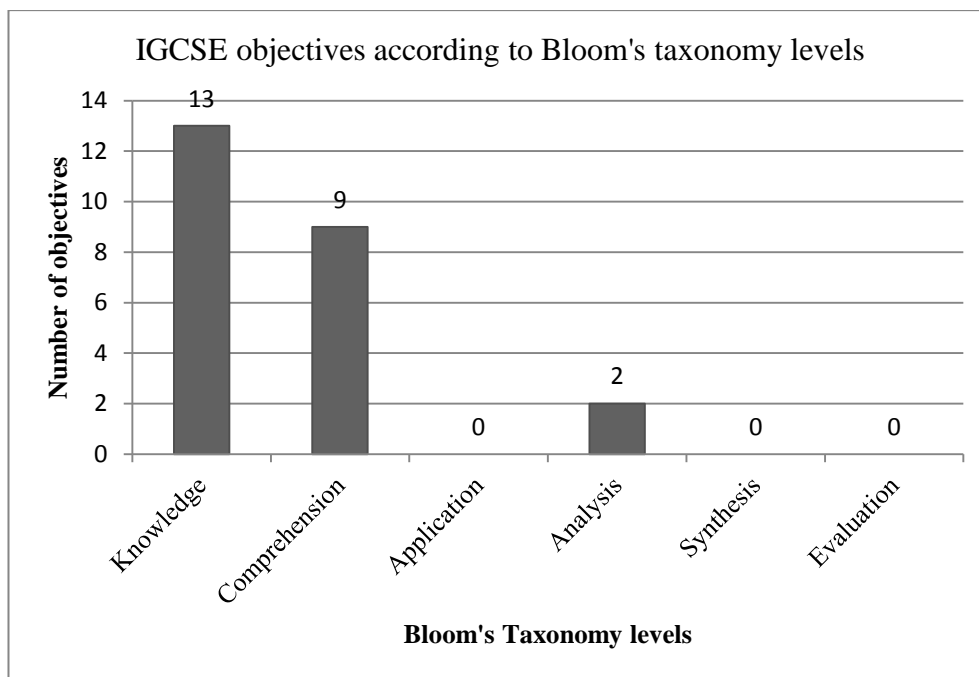


Figure 9. IGCSE objectives according to Bloom's Taxonomy levels

Instructional strategies and assessment technique

While the MEB textbooks and the IBDP textbook present questions at the end of each section and unit, the IGCSE textbook presents questions throughout the units. The questions were categorized according to question types. The results are shown in Figure 10.

According to the analysis, the assessment mainly discussed in the textbooks is summative assessment. The MEB textbooks have different types of questions, and the IBDP textbook mainly has data- related and open-ended questions. The IGCSE textbook mainly has open-ended questions.

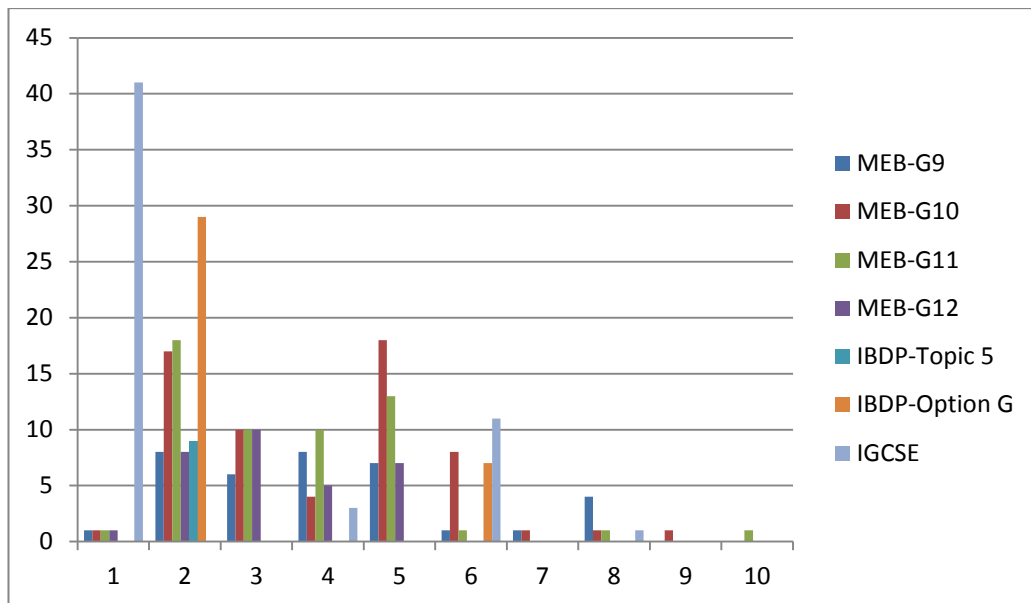


Figure 10. Types of questions in all textbooks

Interviews with MEB, IBDP and IGCSE biology teachers

Interviews were conducted with teachers of the MEB, IBDP and IGCSE biology curricula to obtain their opinions of the biology textbooks used for their respective curriculum. Interviews were conducted face-to-face for the two MEB and the two IB biology teachers while Skype was used to interview with the two IGCSE biology teachers. The questions were patterned after the instrument created by FLDOE. A semi-structured interview technique was used and 22 questions were asked to obtain teachers' opinions (Appendix E). The researcher preferred to ask 18 out of 22 questions, because the remaining four questions were found repetitive. A1 and A2 refer to MEB teachers, B1 and B2 refer to IB teachers and C1 and C2 refer to IGCSE teachers.

Alignment with curriculum requirements

When asked about textbook alignment with their curriculum, all teachers indicated there was a good alignment. However, the MEB teacher (A1) stated that the textbooks should be supported with extra homework and activities.

Level of treatment

Overall, the teachers expressed that the textbooks adequately addressed ecological concepts, but they had some concerns and suggestions (see Table 28). According to IB teachers, the standard level curriculum on its own is not enough to teach ecology concepts fully, unless higher level is also taught to students. Compared to the MEB textbooks, the IBDP textbook fails to address some concepts.

Table 28
Teachers' opinions regarding level of treatment

MEB	IBDP	IGCSE
Objectives are suitable for targeted learning outcomes and for students.	Textbook includes all necessary concepts related to the objectives.	The order of the objectives that is in the curriculum is not followed by the textbook but properly covered.
The language of the textbooks is appropriate for students.	Textbook is for international teaching in a second language, thus the language is appropriate for the age level of students and is clear regarding understanding.	Textbook contains lot of terms that confuse students.
Time is enough for teaching ecology.	Time is enough for teaching ecology.	Time is enough for teaching ecology.

Expertise for content development

The six teachers expressed that only the names of the authors are given and no further information is provided. In addition, MEB teacher (A2) suggested that it would be better if the backgrounds of authors are included.

Accuracy of content

Teachers' opinions regarding accuracy of content are presented in Table 29.

Table 29
Teachers' opinions regarding accuracy of content

MEB	IBDP	IGCSE
Textbook accurately represents the knowledge and concepts of ecology.	Textbook accurately represents the knowledge and concepts of ecology.	Textbook accurately represents the knowledge and concepts of ecology but details confuse students.
The textbooks are objective and free of mistakes and errors.	The textbook is objective and free of mistakes and errors.	The textbook is objective and free of mistakes and errors.
The facts given in the textbook are accurate and cover generally accepted concepts for the area of ecology.	The facts given in the textbook are accurate and cover generally accepted concepts for the area of ecology.	The facts given in the textbook are accurate and cover generally accepted concepts for the area of ecology.

Currentness of content

Teachers' opinions regarding currentness of content are presented in Table 30.

According to the MEB teacher (A1), some of the visuals in the MEB textbook are not up-to-date enough to represent ecological concepts and they do not provide different points of views for students. MEB teacher (A2) emphasized that even the Chernobyl nuclear accident is not known by students. Thus, content should be made more current by giving examples.

IB teachers suggested that the IBDP textbook could include different points of views such as philosophical ideas, which would support the IBDP programme's Theory of Knowledge (TOK). The teachers added that although the content of the textbook did include examples from different countries, the information was not sufficient to teach ecological concepts or issues relating to Turkey.

Table 30
Teachers' opinions regarding currentness of content

MEB	IBDP	IGCSE
The content of textbooks is up to date.	The content of textbooks is up to date.	The content of textbooks is up to date.
Historical and scientific knowledge is current.	Historical and scientific knowledge is current.	Historical and scientific knowledge is current.
All of the photographs are not current enough to represent ecological concepts.	The photographs are current enough to represent ecological concepts.	The photographs are current enough to represent ecological concepts.

Authenticity of content

Teachers' opinions regarding authenticity of content are presented in Table 31.

IB teacher (B1) believes that many ecological concepts are too abstract for students to understand without real-life examples. Therefore, the IB teachers suggested that the IBDP textbook should include more real-life connections to support their efforts to make the concepts more relevant to students.

IGCSE teacher (C1) noted that the questions in the textbook had good interdisciplinary connections; they required students to use mathematics skills to solve calculations and analyze graphs.

Table 31
Teachers' opinions regarding authenticity of content

MEB	IBDP	IGCSE
The textbooks include life connections especially the 9 th grade textbook.	The textbook includes life connections.	The textbook includes life connections.
Textbooks include interdisciplinary treatment. For example, the philosophical view is given in the topic of conservation of environment.	Textbook includes interdisciplinary treatment but only in small amounts.	Textbook includes interdisciplinary treatment (math, chemistry).

Multicultural representation

The six teachers noted that ecological concepts and issues in the six selected textbooks are universal and the contents of the textbooks are fair and advocate for multicultural representation.

Humanity and compassion

The six teachers expressed that there are no problem with regard to humanity and compassion in the six selected textbooks.

Comprehensiveness of student and teacher resources

The IGCSE teachers stated that the teacher resource kit aligns with the curriculum and the textbook. IB teachers noted that they would like to have a teacher's resource.

Logical organization

Teachers' opinions regarding the logical organization of the textbooks are presented in Table 32. MEB teacher (A1) suggested that it would be better if all ecology-related topics were given in one grade. This teacher added that topics relevant to ecology, such as classification and biodiversity could be taught within this grade as well.

Table 32
Teachers' opinions regarding logical organization

MEB	IBDP	IGCSE
The spiral curriculum feature creates disconnections between ecology topics.	SL and HL parts of textbook could follow each other to provide completeness.	The logical organization is good.

Readability of instructional materials

Teachers' opinions regarding the readability of instructional materials are presented in Table 33.

The MEB teachers stated that the text was mainly in Turkish rather than using English terms or Latin names for organisms which help to make the ecology unit more understandable to students. However, the narrative nature of the textbooks tends to bore students.

The IB teachers said that visuals should consist of real photos or more accurate drawings. In addition, the number of visuals should be increased and more information should be given under the visuals to explain them. Finally, they recommended that it would be better if the visuals are numbered, for reference within the text and to increase ease of use.

IGCSE teachers stated that the textbook contains a large vocabulary list which makes it hard to understand.

Table 33
Teachers' opinions regarding readability of instructional materials

MEB	IBDP	IGCSE
The language levels of the textbooks are suitable for the students' age.	The language of the textbook is clear and understandable.	The language of the textbook is clear and appropriate for students' age.
	The visuals are not of good quality.	The visuals are of appropriate quality and suitable for the topic.

Ease of materials use

Teachers' opinions regarding ease of materials use are presented in Table 34.

IB teacher (B1) suggested that HL and SL should be published separately so that the thickness of the textbook is decreased.

Table 34
Teachers' opinions regarding ease of materials use

MEB	IBDP	IGCSE
The costs of the textbooks are cheap enough for students to buy.	The cost of the textbook is high for Turkish standards.	The cost of the textbook is expensive for students.
The textbooks are thin and easy to carry.	The textbook does not have a hard cover to help carry the books more easily.	The textbook is easy to carry.

Pacing of content

Teachers' opinions regarding the pacing of content are presented in Table 35.

IGCSE teacher (C2) indicated that the textbook consistently gives information using vocabulary words which tends to bore students. The questions from past examination papers were good for preparing students for the examination.

Table 35
Teachers' opinions regarding pacing of content

MEB	IBDP	IGCSE
Pace of content is slow because of the narrative explanations.	The pace of content is appropriate.	Pace of content is slow because of a large number of vocabularies.

Motivational strategies

Teachers' opinions regarding motivational strategies are presented in Table 36.

According to MEB teacher (A1), different types of activities should be added to motivate students. MEB teacher (A2) suggested that to better prepare students for university entrance exam, there should be activities and questions related to the analysis and synthesis levels of Bloom's Taxonomy.

Table 36
Teachers' opinions regarding motivational strategies

MEB	IBDP	IGCSE
The number of activities in the textbooks is not enough to teach ecology.	Practical work is important in biology education but the textbook does not offer any.	The textbook does not contain any activities which would help motivate students and allow for feedback.
	The textbook does not provide feedback and do not include motivational strategies.	The only motivational source is visuals and critical thinking questions.

Teaching a few “big ideas”

Teachers' opinions regarding teaching a few “big ideas” are presented in Table 37.

The IB teachers said that the textbook has sufficient details about global warming.

Conservation of nature is given in the optional part of textbook; for effective teaching of ecology it should be in the core part of the textbook.

Table 37
Teachers' opinions regarding teaching a few “big ideas”

MEB	IBDP	IGCSE
The textbooks give “Big Ideas” and necessary concepts for ecology are presented but not in detail.	The textbook gives general ecology content.	The textbook is good at teaching main ecological concepts.

Explicit instruction

Teachers' opinions regarding teaching explicit instruction are presented in Table 38.

Table 38
Teachers' opinions regarding explicit instruction

MEB	IBDP	IGCSE
The instructions of activities could be more explicit to follow.	The textbook is good at producing explicit instruction and the explanations are clear.	The instructions are clear.

Guidance and support

Teachers' opinions regarding guidance and support are presented in Table 39.

Table 39
Teachers' opinions regarding guidance and support

MEB	IBDP	IGCSE
The textbooks provide a chance for students to receive feedback from their teacher.	The textbook does not provide enough guidance and feedback so the textbook should have a teacher book to support teachers.	Important terms in bold. Website links would be good guidance.
Number of activities is not enough for adequate feedback.		

Targeted instructional and assessment strategies

Teachers' opinions regarding targeted instructional and assessment strategies are presented in Table 40.

According to IGCSE teacher (C1) the questions are good at preparing students for examinations. The assessment strategies can be improved by different types of questions such as reading text related questions.

Table 40
Teachers' opinions regarding targeted instructional and assessment strategies

MEB	IBDP	IGCSE
The questions are inadequate in terms of Bloom's Taxonomy.	The questions given in the textbook are for preparing students for exams since they are old IB exam questions.	The questions were appropriate for assessing achievement of objectives.
The cognitive level of questions should be higher since students are expected to develop analysis, synthesis, and evaluation skills.		

CHAPTER 5: DISCUSSION

Introduction

The purpose of this study was to analyze and compare the content, the presentation, and learning the ecology units of six textbooks: four current MEB textbooks, an IBDP textbook and an IGCSE textbook. The second aim of this study was to obtain the opinions of biology teachers who are using the MEB, the IBDP and the IGCSE textbooks in their classrooms to provide supportive evidence. In this chapter, data obtained from the six selected textbooks are discussed.

In this study, following research questions were addressed:

- 1) Which biology textbook has the best coverage of ecology units within MEB, IBDP and IGCSE curricula, when evaluated according to FLDOE evaluation criteria?

Sub-questions:

- How do biology textbooks cover ecology-related topics in MEB, IBDP and IGCSE in terms of content (alignment with curriculum requirements, level of treatment, expertise for content development, accuracy of content, currentness of content, authenticity of content, multicultural representation, humanity and compassion)?
- How do the biology textbooks cover ecology-related topics in MEB, IBDP and IGCSE in terms of presentation (comprehensiveness of student and teacher resources, alignment of instructional components, organization of

instructional materials, logical organization, readability of instructional materials, pacing of content, and ease of materials use)?

- How do biology textbooks cover ecology-related topics in MEB, IBDP and IGCSE in terms of learning (motivational strategies, teaching a few “Big Ideas”, explicit instruction, guidance and support, active participation of students, targeted instructional assessment strategies, instructional strategies and assessment techniques)?
- 2) What are the opinions of biology teachers who use MEB, IBDP and IGCSE textbooks as a source of instructional material about content, presentation and learning of these textbooks?

Discussion of the findings

The findings of this study were based on the content, presentation, and learning provided by the textbooks. The sub-questions were given at the beginning of each sub-heading. Then, the results were discussed with regard to related sub-question.

Content

- How do biology textbooks cover ecology related topics in MEB, IBDP and IGCSE in terms of content (alignment with curriculum requirements, level of treatment, expertise for content development, accuracy of content, currentness of content, authenticity of content, multicultural representation, humanity and compassion)?

Alignment with the curriculum requirements

The analysis concluded that the four MEB biology textbooks are parallel to the MEB biology curriculum and the IBDP textbook is parallel to the IB biology guide in terms of correlation, scope and completeness. The IGCSE textbook states same objectives but arranged in a different order and worded differently. The IGCSE, the MEB and the IBDP textbooks properly cover the objectives given in the curricula and align with curriculum requirements. The interviewed teachers agreed with this analysis as well.

Level of treatment

The MEB textbooks complement the spiral feature of curriculum design to support the age appropriateness of topics. The ecology-related units are spread from grade 9 to grade 12; however, grade 12 topics are low level in terms of age appropriateness. The ecology-related units start with simple concepts and move to complex concepts. In each textbook, topics begin with daily life examples or interdisciplinary treatment which helps the beginning of units to be simple to start.

The IGCSE textbook is used in Turkey for grades 9 and 10 and the IBDP textbook is used for grades 11 and 12. In that regard, the IGCSE textbooks may not be suitable for students' age level. The IGCSE teachers supported that students are confused about some of the detailed information given in the textbook. Since the IBDP textbook is for grades 11 and 12 and has SL Topic 5 and HL Option G parts and differentiates topics from simple to complex, it is appropriate for age level of students. Topics directly start with explanations or knowledge which make difficult

to start. Like the IBDP textbook, the IGCSE textbook directly starts with knowledge and explanations.

Expertise for content development

All of the textbooks have the authors' names printed on them except the 12th grade MEB textbook. According to MEB (2012), the author should be a specialist in the subject. The requirement is that authors should have minimum undergraduate degree or doctoral degree (PhD) in the subject or they should have published a textbook. Thus, with this acknowledgement, MEB textbooks may not include background information regarding authors.

Sewell (2004) discussed that in some cases, a name may be cited as author without having any contribution to textbook. Providing information about the authors can help assure teachers of the expertise and knowledge level of the authors. Some teachers supported the idea that background information regarding authors is important to include.

Accuracy of content

The six selected textbooks use scientific names and Latin names. Each of the textbooks contained errors regarding Latin names. Scientific names, Latin names, are used universally to identify particular organisms which are living or extinct (Assumption University of Thailand, 2001). According to Thompson (2007) Latin names are used as an essential language by scientists to communicate about biodiversity. In the literature, language method of textbooks and misspelling problems were detected in the textbook analysis studies (Yapıcı, Coşkun & Akbayın,

2009). Since Latin names represent organisms throughout the world, they should be free of errors (Table 13).

Visuals in the six selected textbooks were investigated and magnification errors regarding organisms were found in each, especially in diagrams explaining food chains and food webs. Errors of size representation may cause misunderstanding regarding the actual size of organisms. As stressed in the literature review, accuracy of content is important to support students' conceptual understandings. Cook (2008) summarized in a study that illustrations should present sufficient information to promote students' understanding. A recent research study by Yapıcı, Coşkun and Akbayın (2009) also indicated that grade 10 MEB textbooks suffered from disproportion problem in food chain and food web topic. As in past research, the analysis of the textbooks in this study revealed that such a problem continues to a certain extent, but is generally of better quality than before.

The opinions of MEB and IB teachers are parallel to findings. Only the IGCSE teachers stated that information in detail confuses students, which is not considered in analysis results.

Currentness of content

All six of the selected textbooks were published in recent years. Demirkaya Gedik (2008) discussed the importance of current events in social studies textbooks. She stated that current events are important for students to build life relevancy and apply their learning to daily life. In that regard, since ecology-related units cover social topics like environmental issues, currentness of content is crucial, to achieve effective ecology and environmental education. This study showed that real-life

connections in the six selected textbooks are sufficiently up to date to represent current ecological issues. The IBDP and IGCSE teachers interviewed for this study concurred with this analysis. However, MEB teachers stated that some of the photographs are not up to date enough to teach ecological concepts and suggested presentation of more current photographs.

Authenticity of content

Meaningful content is important in students' learning process, and life connections make the content of textbooks meaningful for students. Moreover, life connections provide motivation and sustain the attention of students (FLDOE, 2008).

The MEB and the IBDP textbooks provide a large number of real life connections (Table 14). The IGCSE textbook, however, contains only a few connections. Pop-Păcurar and Ciascai (2010) stated that if the content of the textbook lacks daily life examples, it produces distance between students and textbooks. In time, students lose their interest towards biology. According to Tekkaya, Özkan and Sungur (2001) students learn ecology easily because they can relate concepts to daily life. In this context, it can be concluded that the MEB textbooks and the IBDP textbook are advantageous regarding life connections.

Interdisciplinary treatment is another important point in the authenticity of content. The learning of students improves when textbooks includes interdisciplinary explanations and activities that transfer skills and knowledge between subjects (FLDOE, 2008). In that regard, throughout the ecology units in the MEB textbooks, activities and examples aim to transfer skills and knowledge of subjects (Turkish language and literature, geography, chemistry, mathematics, history, art and use of

technology) to ecology units. Compared to the MEB textbooks, the IBDP and the IGCSE textbooks contain a few links to other subjects (mathematics, chemistry). Parallel to these findings, Caravita et al. (2008) stated that “Environmental education requires a systemic approach for the interpretation of the environmental issues and depends on collaboration among teachers of different subject matters for the integration” (p. 101).

The opinions of teachers supported the results that all of the textbooks include life connections and interdisciplinary connections.

Multicultural representation

All the MEB, IBDP and IGCSE textbooks support multiculturalism by providing examples from many different countries and cultures. It is expected from developed countries that universal principles in education should be considered and intercultural interactions and universal values should be accelerated. Although the MEB textbooks are designed to be used by Turkish students, the textbooks include universal problems and examples. In that regard, teachers noted that students have positive notions about other cultures.

The IBDP and the IGCSE textbooks are designed to be used by students from many different countries; therefore it is no surprise their multicultural content is strong. Sadly, they do not provide any examples related to Turkey; therefore, Turkish students may find it difficult to focus on local environmental issues.

Humanity and compassion

Textbooks should include sufficient care and treatment of animals and people, as well as sympathy, compassion and consideration of values and needs for all

organisms. At the same time, a textbook must omit inhumane treatment and sexism (FLDOE, 2008). According to Rosenberg (1973) teaching materials should be prepared for all children without any exception. In this context, none of the textbooks included inhumane treatment or sexism which is a positive feature. In addition, the MEB textbooks supported compassion with suggestions to protect the environment; conservation of nature can promote students' positive perspectives regarding nature and biodiversity. The interviewed teachers' opinions aligned with these findings.

Presentation

- How do the biology textbooks cover ecology-related topics in MEB, IBDP and IGCSE in terms of presentation (comprehensiveness of student and teacher resources, alignment of instructional components, organization of instructional materials, logical organization, readability of instructional materials, pacing of content, and ease of materials use)?

Comprehensiveness of student and teacher resources

Resources include a teacher book as well as a student book. Student and teacher books must be complete enough to meet the objectives of the subject. Additionally, teachers should not need to prepare extra teaching material for the course (FLDOE, 2008).

Only the IGCSE textbook possesses a teacher resource kit. It provides additional teaching material for teachers (worksheets, animations, practical works, and trial exam papers) and this is an advantage for the IGCSE textbook. The IGCSE teachers were pleased about IGCSE teacher's resource kit. The MEB teachers and the IBDP

teachers indicated that a teacher's book would be helpful and supportive for their teaching efforts.

Alignment of instructional components

Student materials and teacher materials must align with the curriculum and with each other (FLDOE, 2008).

The IGCSE textbook and its teacher resource are aligned. However, the IGCSE textbook does not follow the order of topics in the curriculum, thus parallelism between the teacher's resource kit and the IGCSE curriculum is not expected. Neither the MEB nor the IBDP has a teacher resource kit, therefore analysis of alignment was not conducted.

Organization of instructional materials

Both the IBDP textbook and the IGCSE textbook give objectives for the units at the beginning of chapters. This is good for students so that they understand what they should learn. All of the textbooks have color coding, but only the IGCSE textbook indicates the difficulty level of questions with yellow highlighting. This is a helpful feature, and both students and teachers understand the importance of the question.

The MEB textbooks have a bibliography and glossary but neither the IBDP nor the IGCSE textbooks include these features (Table 15). This is a negative point for these two textbooks, in that students cannot easily find the vocabulary words from the glossary.

The textbooks contain visuals that are related to texts. Unlike the IBDP and the IGCSE textbooks, the MEB textbook has a large number of visuals. This is a useful

feature for the teacher (see discussion about visuals under the sub-heading of accuracy of content).

The MEB textbooks and the IBDP textbook have small boxes which are introduced at the beginning of each textbook. The IGCSE textbook does not boxes, presents information and knowledge in bite-sized chunks. This feature eases the cognitive load of the textbook as mentioned later (see pace of content).

The MEB has the most pages devoted to the topic of ecology. This is because ecology is included in all four years of student learning and the language of textbooks is like telling a story. The IBDP textbook has the least number of pages of the textbooks compared (Table 16).

Logical organization

Spiral curriculum is a popular sequencing approach. Each new topic is related to one or more previous topics, with new information and content added, and tasks becoming more complex (FLDOE, 2008). Spiral curriculum is applied both to the MEB curriculum and the MEB textbooks, with ecological content being addressed throughout grades 9 to 12. The topics are expanded in each grade, with key concepts containing more information as they go from simple to complex, known to unknown, and concrete to abstract (MEB, 2011 a). This study showed that having a spiral curriculum is an advantage for the MEB textbook. The curriculum should repeat basic ideas while building on them, and thus directly affect learning (Bruner, 1960).

On the other hand, some researchers criticize spiral curriculum (Eker, n.d), indicating that it might spread a topic out too thinly and interrupt continuous study. The alternative is to concentrate a topic in one year so that students learn it all at the same

time without any separation. The opinions of the MEB teachers were parallel to this idea; they stated that a spiral curriculum causes disconnection between ecology-related units.

The IBDP textbook provides ecology topics in Topic 5 and Option G. Like the MEB textbooks, Option G contains more complex and detailed information about key terms. Teachers can choose to teach Option G or not. When teachers choose not to teach option G, students learn concepts only in Topic 5.

Readability of instructional materials

According to Erol and Kirođlu (2005) textbooks should present important features in terms of language and expressions. Expressions should be explicit and understandable. The age level should be considered when abstract terms are used.

A large number of technical terms are used in science because of the nature of science. These terms are often difficult to understand by students. Biology, especially when compared to physics, chemistry and other sciences, has many readability issues with its large number of concepts, theories and principles (Özay, 2009).

The ease of readability and readability levels of the IBDP textbook Topic 5 section and MEB textbooks in grades 9, 10 and 12 were found to be moderately difficult (IBDP Topic 5 60.17; Grade 9 53.07; Grade 10 52.31; Grade 12 52.07). This finding corresponds to a recent study where a researcher rated the readability level of grade 10 MEB textbook as moderately difficult for Photosynthesis and Cellular respiration topic (İnanç Gök, 2012). This finding conflicts with another study that determined the readability level of grade 9 MEB textbook as easy for the unit on cells (Özay, 2009). One reason for these differences might be because of the varying nature of the

topics. Readability ease and readability level of grade 11 is determined as 48.7 and difficult to read. Likewise, readability ease and readability levels of Option G of the IBDP textbook and the IGCSE textbook was determined as easy (Option G 71.67; IGCSE 72.7). Visuals are important in the communication of science concepts (Ametller & Pinto, 2002). In that regard, their quality and numbers are important in teaching ecological concepts. In this research, the MEB textbooks contained the most number of visuals, and the IGCSE textbook contained the lowest number of visuals (Table 24). Illustrations in the textbooks are good enough to represent ecological concepts. The opinions of MEB and IGCSE teachers supported the finding that visuals are good quality and suitable for the topic. However, the IBDP teachers noted that visuals should be better.

Pacing of content

Containing bite-size chunks or blocks of information is an important feature for instructional materials. To avoid overwhelming students, the chunks should not be too small or too large (FLDOE, 2008). In this regard, all of the textbooks present information boxes which are advantageous. Quiroga, Croscy and Iding (2004) stated that organized information is reducing the overwhelming cognitive load. However, according to interviewed teachers, pace of content is slow because of the large number of vocabulary words in text.

The MEB textbooks use a story-telling approach to presenting their biological content; therefore, reading explanations and gaining information takes time.

Although, the IGCSE textbook contains many terms, they are presented in small boxes. The visuals of the IGCSE textbook help ease the cognitive load as

recommended by FLDOE (2008). In this context, it can be concluded that the IGCSE textbook is good at the pacing of content and in terms of adequate visual support.

Ease of materials use

None of the textbooks has a hard cover which helps reduce the weight of the books; however, the IBDP textbook is 710 pages long and this makes it heavy to carry. The MEB textbooks are cheapest textbooks. The IBDP and IGCSE textbooks are very expensive which may cause affordability problems. The opinions of interviewed teachers are parallel to findings.

Learning

- How do biology textbooks cover ecology-related topics in MEB, IBDP and IGCSE in terms of learning (motivational strategies, teaching a few “Big Ideas”, explicit instruction, guidance and support, active participation of students, targeted instructional assessment strategies, instructional strategies and assessment techniques)?

Motivational strategies

As discussed in the literature review, the language style of textbook is a factor in motivating students. This study found that the story-telling format of the MEB textbooks was the most friendly language style. The language is like someone talking to you and can be more engaging for the students. As stated earlier, the large number of real-life examples in the MEB textbooks also helps to make the content more meaningful and motivating for students (Table 14).

Activities are another factor in motivation. According to Johnstone and Al-Shuaili (2001) practical work increases students' motivation and students feel ownership of their learning. The MEB textbooks contain a variety of activities and practical work and are better than the IBDP and the IGCSE textbooks regarding these types of motivational strategies. Interviewed teachers support the analysis result that activities as a motivational strategy should take place in a large amount.

The IGCSE textbook contains very few real-life connections and the language style is more scientific and monotonous. This study concluded that the IGCSE textbook has less motivational strategies in terms of language and relativity to real life.

One of the key motivational features of the IBDP textbook is its use of website links (neither the MEB textbooks nor the IGCSE textbook contain Internet links). The IBDP textbook has another advantage for motivation with its use of technology. Başer and Yıldırım (2012) stated that technology is a useful tool to attract students, consolidate their knowledge and provide better permanent understanding.

Teaching a few “Big Ideas”

The fundamentals of ecology are required for understanding connections between the environment and human communities. In addition, the fundamentals of ecology are critical to understanding the impacts of human actions on the environment (EETAP, 2002).

The MEB textbooks cover the most number of ecological key concepts (Table 25). Environmental ethics is presented only in the MEB textbook. This study found that the IBDP textbook and the IGCSE textbook cover the same number of ecological key concepts. Surprisingly, the IBDP textbook does not cover nutrient cycling which,

according to EETAP (2002), is an essential ecological concept. The six interviewed teachers supported the analysis result that most of big ideas were presented in the textbooks.

Explicit instruction

Archer and Hughes (2011) defined explicit instruction as “a structured, systematic and effective methodology for teaching academic skills” (p.1). Each of the textbooks analyzed in this study has its own approach for providing explicit instruction. The IBDP textbook and the IGCSE textbook give explicit objectives for each section, which aid teachers in knowing what to teach and help students understand what to learn. Instructions in the MEB textbooks, the IBDP textbook and the IGCSE textbook are clear and understandable. Activities of the MEB textbooks are explicit enough to follow step by step. Neither the IBDP textbook nor the IGCSE textbook offers activities for students. Therefore, it is not possible to discuss activity instructions of these textbooks.

All teachers noted that instructions of the six selected textbooks are clear.

Guidance and support

This study revealed that the MEB textbooks offer the greatest number and variety of activities; neither the IBDP textbook nor the IGCSE textbook offer any activities for students (Table 27). The teachers’ opinions support that activities are important in biology teaching and should be present in textbooks. Even though the MEB textbooks include activities, teachers would like to see more. According to FLDOE (2008) the average student needs scaffolding to acquire knowledge and skills.

According to Science Community Representing Education (SCORE) (2008), good

quality practical work helps students to develop skills, knowledge and conceptual understanding by promoting students' interest.

In addition to practical work, Glynn and Takahashi (1998) stated that analogies are helpful for meaningful learning. Both the MEB and IBDP textbooks make use of the most number of analogies to explain ecological concepts, with MEB containing the most (Table 26). The IGCSE textbook does not contain any analogies. Uğur, Dilber, Senpolat and Duzgun (2012) point out that analogy may cause misunderstanding and impaired learning when they are not used effectively; therefore, it may be a benefit for the IGCSE textbook not to include analogies. Opinions of the teachers are parallel to analysis results.

Active participation of students

Success in science depends on the coordination of teacher, student and educational technologies and additionally the content, educational design and physical features of textbook may influence success in science (Bakar, Keleş & Koçakoğlu, 2009). Only the MEB textbooks offer a large number and different types of activities to encourage activity participation of students (Table 27). The IBDP and the IGCSE textbooks do not contain any activity. Since activities and practical work are an essential part of biology teaching, the MEB textbooks are better in terms of educational design. The MEB textbooks provide opportunities for students to perform their skills and concrete their learning.

At the beginning of each activity outcomes are written. This is good for teachers to check whether they have achieved the targeted objectives or not. Activities support group working, thus, collaborative learning. According to Gokhale (1995) the

concept of collaborative learning is an instructional method which helps students working in small groups to achieve a goal, as well as method improving their critical thinking skills.

In the MEB textbook, students are expected to do some practical work through activities. Therefore, students are actively engaged to activities and improving their knowledge. Teachers pointed out that when using these textbooks, they need to refer to other resources to support student involvement and active participation.

Targeted instructional assessment strategies

Since the MEB curriculum delivers ecology topics in four textbooks, the MEB textbooks have the largest number of objectives. However, most of these objectives focus on student comprehension which, according to Bloom's Taxonomy, is a low level of cognitive development (Figure 7). Compared to the other textbooks, Option G of the IBDP textbook has more objectives which encourage analysis which involves higher level thinking skills (Figure 8). Application of knowledge is a required higher-order cognitive skill (Zoller, 1993). The IGCSE textbook objectives fall mainly with the knowledge level of Bloom's taxonomy which is even lower than comprehension (Figure 9). Students are expected only to recall the knowledge that is required (Zoller, 1993). Since the MEB curriculum expects students to gain analysis, synthesis and evaluation skills, the teachers interviewed in this study agreed that textbooks should focus on higher order cognitive skills.

Instructional strategies and assessment techniques

The MEB textbooks have the greatest variety of questions. Questions are a chance for students to test themselves on their understanding of content. Different types of

questions are used to elicit the knowledge in different cognitive levels (Bridgeman, 1992; Martinez, 1999). For example, data-related questions allow students to select the correct answer while open-ended questions encourage students to formulate answers. The IBDP textbook offers data-related and open-ended questions. As indicated by the teachers interviewed, these questions are often taken from past IB exams. Likewise, the IGCSE textbooks use questions from past exams which teachers approve of. This study concludes that both the IBDP and the IGCSE textbooks help prepare students for examinations.

Conclusion

In conclusion, the six selected textbooks designed to meet the MEB, the IBDP and the IGCSE curricula have weak and strong points.

From the perspective of content, the four MEB textbooks come before the other two textbooks. The MEB books provide more real life examples, and are more interdisciplinary.

From the perspective of presentation, the IGCSE textbook provides teachers with resource kits and uses bite-size information or chunked content to help regulate the pace of study. The inclusion of websites in the IBDP textbook helps with presentation.

From the perspective of learning, the MEB textbooks are better than both the IBDP textbook and the IGCSE textbook. The story-telling language style of the MEB textbooks is the most inviting for ease of reading. The MEB books also promote learning by encouraging student participation with different types of activities and a variety of questions. However, the study found that the objectives and questions in

the MEB textbooks do not promote higher level thinking skills, which are found more in the IBDP textbook.

Implications for practice

Effective science teaching requires qualified teachers, well planned curricula and well-designed textbooks. Textbooks are the main instructional resource to meet the objectives of biology curriculum. Well-prepared biology textbooks help teachers to teach the fundamentals of ecology and provide opportunities for students to gain skills and knowledge. Therefore, textbook preparation and textbook selection requires intensive care of the teachers and the schools.

This study used the FLDOE evaluation criteria to assess the effective instructional materials of six different textbooks and found various weak and strong points among them.

This study also indicated that an effective textbook should align with the curriculum, and identified some fundamental features of a well-designed textbook. These features should be considered when selecting textbooks. For example, real-life relevancy is important for students to make connections with daily life. The language level should be appropriate for students' age, and the style of language should be friendly enough to engage students. Assessment through questioning is essential for the teacher to check students' understanding and for students to make their self-assessment.

Different types of activities are important for students in terms of providing them with opportunities to gain skills and knowledge.

Textbooks are used by both teachers and students. Hence, textbook analysis studies should consider both students' and teachers' perspectives of teaching and learning.

Accordingly, textbook analysis studies should be taken into account during the textbook selection process.

As can be deduced from this study, textbook evaluation relating to ecology units has many criteria to focus on. Therefore, effective evaluation criteria are crucial in textbook selection process. Teachers and schools should pay attention to find well-planned criteria.

Finally, the textbook writers should be experts in their profession. The textbook committee should include language expert, program developer, assessment and measurement expert, guidance and counseling expert and visual designer to improve quality and effectiveness of textbooks.

Implications for further research

Of the six textbooks selected, four were from the MEB. Since only one IBDP and one IGCSE textbook was analyzed, other biology textbooks which implement the IBDP and the IGCSE curricula can be studied.

Ecology-related units from each textbook is selected for analysis, number of units can be increased. More than one unit gives more reliable findings about content, presentation and learning perspectives of the selected textbooks.

Students and teachers use textbooks as a source of instruction. Therefore, opinions of students about the selected textbooks can be included in the study.

Two teachers for each curriculum are included to this study from the three schools. More schools and more teachers can be included to next studies for better reliable results.

The evaluation material used for this study was intended to evaluate an entire textbook, while in this study only ecology-related units were analyzed. The evaluation material only for a chapter analysis can be used in another study.

Biology curriculum was changed by Board Education at the beginning of 2013. New biology curriculum can be studied in a future study.

Limitations

There are several limitations of this study that may affect analysis results. One of the limitations is that only one topic, ecology, is analyzed in textbooks which implement three different curricula. Findings depended only in the ecology-related units in these textbooks.

The MEB curriculum has spiral feature and the MEB textbooks present ecology-related topics at four different grades (9-12th) in secondary school. However, the IGCSE curriculum is taught to 9th and 10th graders and the IBDP curriculum is taught to 11th and 12th graders. Accordingly, the MEB textbooks have the benefit of being four textbooks in terms of page numbers, life connections, age appropriateness, number of objectives.

Another limitation is the number of teachers interviewed. For the interviews, two teachers were chosen as representatives of each curriculum. In total, only six teachers are included in this study.

The IBDP curriculum and the IGCSE curriculum are implemented as international curricula. The MEB curriculum focuses on national education, and therefore, the content of Turkish textbooks mainly address national issues and examples.

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APPENDICES

APPENDIX A: Paragraphs from the MEB textbooks

Grade 9

Asit yağmurları, fosil yakıt atıklarının doğal su döngüsüne karışmasıyla oluşur. Kömür ve petrol gibi fosil yakıtların yakılması sonucu atmosferde kükürt ve azot içeren gazlar birikir. Bu gazlar havadaki su buharıyla tepkimeye girer. Güneş ışığı da bu tepkimelerin hızını artırır. Bunun sonucunda da sülfürik asit, nitrik asit damlları oluşur ve pH'si 5,6'dan düşük olan asit yağmurlarına dönüşür. Yağmurların dışında yağış, asit oranı düşük kar ya da sis şeklinde de olabilir. Yoğun oranda hidrojen iyonu içeren yağışlar toprağa ulaştığında kalsiyum, potasyum ve magnezyum gibi elementler ile tepkimeye girer. Bu olay sonucunda da bitkilerin kullandığı bu elementlerin topraktaki miktarı azalır. Doğal ortamdaki bitkilerin (p.213)

Yanlış aydınlatma çevremizdeki doğal hayatı da olumsuz etkilemektedir. Bazı deniz hayvanlarının yuva yaptığı yerler ışık kirliliği ya da yapay aydınlatma yüzünden tehlikededir. Yumurtadan çıkan binlerce deniz kaplumbağası yavrularının yalnızca birkaçı denize ulaşabilmektedir. Denize ulaşmak için deniz ile kara arasındaki aydınlık farkını kullanan kaplumbağalar yapay ışıklandırmalarla karaya yönelince hayatlarından olmaktadır. Avustralya'da yapılan bir araştırmaya göre mercanların, üzerlerine düşen aşırı ışık yüzünden kendilerine renk veren mikroskobik bitkileri reddettikleri, beyazlaştıkları ve strese girdikleri bildirilmiştir. Işık kirliliğinin önlenmesi konusunda hepimize görev düşmektedir. Bunun için doğru aydınlatmayla ilgili bilgi sahibi olmalı, doğru aydınlatma kurallarına uymalı, çevremizdeki yanlış

ve rahatsızlık veren uygulamaları ilgililere duyurmalıyız. Aydınlatma yaşamımızın (p.224)

Atatürk, doğa ve çevre anlayışıyla günümüzdeki şehircilik, çevre ve tabiat güzelliği kavramlarına ışık tutmuştur. Bu kavramların bilinmediği ve konuşulmadığı o yıllarda, şehircilik uzmanlarını getirterek Cumhuriyet'in başkenti Ankara'yı düzene sokan, ağaç diktiren, bulvarlar açtıran, orman çiftliğini kuran, yeşillığe imkân veren Atatürk, her zaman örnek alınması gereken eşsiz büyük bir önderdir. Atatürk'ün doğayı, ağacı sevmesinin en belirgin örneklerinden birisi de kuşkusuz Atatürk Orman Çiftliği'dir. Atatürk 1925 yılında kendi aylığından ödeyerek çiftliğin bugünkü yerini satın almıştır. O yıllarda bu topraklar, ortasından demir yolu geçen bataklık ve boş bir araziydi. Atatürk o (p.240)

Grade 10

Canlıların yeryüzündeki dağılışı ışık, sıcaklık, iklim, toprak, mineraller, su ve pH gibi abiyotik faktörlerin etkisindedir. Abiyotik faktörlere aynı zamanda çevrenin fiziksel ve kimyasal etkenleri de denir. Genelde ilkbahar ve yaz mevsimlerinin görüldüğü, aşırı yağış alan, tropikal yağmur ormanları gibi fiziksel şartların uygun olduğu yerlerde zengin tür çeşitliliği ve çok sayıda canlı bulunurken çöller ve kutuplar gibi yaşam şartlarının zor olduğu ortamlarda az sayıda canlı bulunur. Kısacası abiyotik faktörler belirli bir çevrede hangi türlerin yaşayabileceğini belirler. Örneğin çöllerde havadaki nem oranı çok düşük olduğundan gece ve gündüz arasındaki sıcaklık farkı oldukça yüksektir. Böyle bir ortamda ancak çok miktarda su depolayabilen kaktüs (p.183)

Besin zincirleri ve besin ađlarında turler ekolojik etkileri bakımından birbirlerine bađımlı olduđu iin bazı turler bütun sistem üzerinde önemli etkilere sahip olabilir. Böyle turlere kilittaşı turleri adı verilir. Komünitede kilittaşı turlerin birey sayısı diđer turlere göre az olsa da etkileri fazladır. Kilittaşı turlerden herhangi birinin neslinin tükenmesi ekosistemdeki trofik düzeyler üzerinde olumsuz yönde büyük etki yapar. Örneđin Kuzey Pasifik'te kıyı ekosisteminde kilittaşı tür su samurudur. Su samurları, deniz kestanelerini yiyerek beslenir. Deniz kestaneleri de ok hücreli alglerden olan kelpeleri besin olarak tüketir. Kelpeler birçok tür için habitat oluşturur. Bu ekosistemdeki su samurları yok olursa deniz kestanelerinin sayısı artar. Bu da (p.203)

Biyosfer II'de yerkürede bulunan dere, bataklık, tropik yağmur ormanları, savan, öl gibi önemli biyom tipleri, bu alanlara özgü belirli bitki ve hayvan turleri bulunmaktaydı. Bu yapay ekosistemde buharlaşma ve terlemeye bađlı yağmurların yağmasına kadar her şey planlanmıştı. Bütun besin maddeleri BiyosferII'nin iinde üretiliyordu. Sekiz gönüllü bilim insanı da iki yıl boyunca sistemin bir parçası olarak BiyosferII'de kalmış ve orada alışmıştı. 200 milyon dolara mal olan bu projenin amacı başka gezegenlerde insanın yaşayabileceđi istasyonların kurulmasına model oluşturmaktı. Ancak sistem en fazla iki yıl kendi kendine yeterli olabilmıştı. Bu sürede temiz su sađlayan sistem kirlenmiş, göller yosunlar ile kaplanmış tarla bitkilerinin yerini (p.223)

Grade11

Tür ii ve turler arası rekabet, hayvan ve bitki popülasyonlarındaki büyümeyi sınırlayan ve dengede tutan önemli faktörlerden biridir. Popülasyonların sađlıklı bir şekilde varlığını sürdürebilmesi, su, besin, ışık, yaşama-ođalma alanları vb. sınırlı

bazı çevresel kaynakların kullanımı ile ilgilidir. Yaşama alanına en iyi uyum sağlayan tür, bu ortamdaki diğer türlerle en iyi rekabet edebilen türdür. Rekabeti etkileyen önemli faktörlerden biri de türlerin gelişme ve olgunlaşma dönemlerinin farklı olmasıdır. Bu dönemler ne kadar farklıysa türler arasındaki rekabet o ölçüde azalır. Türler arası rekabet bitkisel üretim açısından da önemlidir. Örneğin gerek kültür bitkileriyle yabancı ot arasındaki rekabet gerekse mısır-soya, mısır-fasulye gibi karışık ekimlerde farklı (p.205)

Popülasyon büyüklüğü birçok faktörün kontrolü altındadır. Türler arası rekabet, av-avcı ilişkisi, sıcaklık, yağış, ışık, toprak, besin vb. faktörler popülasyonun büyümesini etkiler. Bu nedenle hiçbir popülasyon bulunduğu ortamda sınırsız çoğalamaz. Popülasyonun birey sayısındaki artış bireylerin büyüme, üreme ve beslenme için yeterli kaynak sağlamalarını engeller. Belirli özelliklere sahip bir yaşama ortamında bulunabilecek en fazla birey sayısı, **taşıma kapasitesini** belirler. Örneğin bir kovandaki arı popülasyonu, başlangıçta az sayıda bireyden oluşurken bir süre sonra popülasyondaki birey sayısının arttığı gözlenir. Popülasyondaki arı sayısının kovanda bulunabilecek en yüksek sayıya ulaşmasıyla popülasyon maksimum taşıma kapasitesine ulaşır. Popülasyon taşıma kapasitesine ulaştınca büyüklüğünde inişli çıkışlı dalgalanmalar görülür. Popülasyondaki dengenin (p.217)

Türün dağılımı, bir organizmanın bulunduğu alandan, üreyebileceği başka alanlara yayılmasıdır.

Belirli bir fiziksel çevrenin güneş ışığı, sıcaklık, su, toprak ve minerallerden oluşan koşulları, biyolojik çevrenin özellikleri, bitki ve hayvanların dağılımına etki eder. Örneğin fi l ana vatanı Afrika Kıtası olmakla birlikte, Asya'da da yaşar. Çünkü bu iki kıtanın bazı bölgelerinde, fi llerin yaşamlarını devam ettirebilmeleri için uygun

koşullar vardır. Herhangi bir tür yeni bir coğrafi k alana yerleştiği zaman bu alana hızla yayılır. Örneğin İtalyan bal arısına göre daha fazla bal üreten Afrika bal arısı Brezilya'ya getirilmiş; ancak bir kaza sonucu kaçan bal arıları Amerika Kıtası'na yayılmıştır. Afrika bal arıları (p.230)

Grade 12

Yaşamın vazgeçilmez madde ve besin kaynaklarından biri olan su kaynaklarının sürdürülebilirliğinin önemi oldukça büyüktür. Çünkü su kaynaklarından, içme ve temizlik suyu ihtiyacımızı karşılamak, tarım alanlarını sulamak, suda yaşayan çeşitli canlıları besin olarak kullanmak vb. pek çok alanda yararlanıyoruz. Bu yararlanma yüzyıllar boyunca su kaynaklarının kendini yenilemesi ve sürdürülebilir olması nedeni ile sorunsuz bir şekilde devam etmiştir. Ancak son yıllarda su kaynakları da toprak gibi, hızla kirlenmeye ve sürdürülebilirliğini yitirmeye başlamıştır. Çünkü artan nüfusa bağlı olarak su talebi de artmıştır. Aşırı su (p.219)

Kirlenme” son yıllarda adını çok sık duyduğumuz bir sözcüktür. Çevremizde hava, su, toprak kirlenmesi gibi pek çok kirlilik çeşidi oluşmuş durumdadır. Ancak bu çeşit kirlenmelerin dışında, gözle göremediğimiz bir kirlenme şekli daha vardır ki bu, genetik kirlenme olarak adlandırılır. Genetik kirlenme, bir bölgede yaşayan canlıların oluşturduğu popülasyonların “gen havuzunda” oluşan ve canlının soyunun bozulmasına yol açan bir kirlenme şeklidir. Genetik kirlenme bir bölgede yaşayan ve milyonlarca yılda o yöreye uyum sağlamış olan yerli ırklar yerine melez türlerin yetiştirilmesi ile ortaya çıkar. Daha fazla verimliliğe sahip, ıslah edilmiş ya da melezlenmiş bu türler yetiştirildikleri bölgede bulunan yerli ırklar ile eşleşerek taşıdıkları (p.226)

Yaşadığımız çevredeki kaynakları tüketmeden gelecek nesillere taşımak için sadece korumak yeterli değildir. Aynı zamanda doğal kaynakların sürdürülebilirliğini sağlamak da gereklidir. Bu kaynaklardan kendilerini yenileyebilme süresine uygun olarak yararlanılırsa kaynaklar uzun yıllar varlığını sürdürebilir. Ancak son yıllarda karşılaştığımız pek çok örnekte olduğu gibi çevre etiğini hiçe sayarak, aşırı kaynak kullanımı bu kaynakların hızla tükenmesine neden olmaktadır. Örneğin Konya Ovası, etrafı dağlarla çevrilmiş çanak şeklinde bir bölgedir. Bu dağlar nedeniyle çevresindeki alanlardan izole olmuştur. Bu sayede bu havzada kendine özgü iklim ve bitki örtüsü oluşmuştur. Bu havza, ülkenin buğday deposu olduğu için ticari öneme sahiptir. Konya Ovası Anadolu'nun soğuk ve kuru iklimini (p.230)

APPENDIX B: Paragraphs from the IBDP textbook

Topic 5

Once light energy has been absorbed by producers, the chemical energy obtained by photosynthesis is available to the next trophic level. Energy is transferred from one organism to the next when carbohydrates, lipids or proteins are digested.

When grass is eaten by a cow, chemical energy is transferred to the cow. However, if a clump of grass dies without being grazed on, decomposers such as fungi will use the energy it to offer.

Inside the cow, the chemical energy is used for cellular respiration. Any heat generated by cellular respiration is lost to the environment. If the cow is eaten, (p.118)

Concerned scientists say that money spent now on preventative measures is not money wasted. Rather, it is an investment for a sustainable future. It is often much less expensive to prevent a problem than to fix it.

The precautionary principle is used in the field of medicine where it is preferable to prevent a disease rather than to wait for a patient to become ill. Why not apply this principle to health of the planet Earth, too? It is up to each consumer, each manufacturer and each government to make decision.

There is an ethical issue here: one of the most unjust (p.129)

No habitat can accommodate an unlimited number of organisms- populations cannot continue to grow and grow forever. As you have just seen, there comes a time in the growth of a population when its numbers stabilize. This number, the maximum number of individuals that a particular habitat can support, is called the carrying capacity and its represented by the letter K.

Consider, for example, a given area soil in a forest. There is a maximum number of trees which can grow there. This number is attained when enough trees are present to catch all the sunlight, leaving every square metre (p.133)

Option G

The red fox habitat is the forest edge. Its food consists of small mammals, amphibians and insects. It interacts with other species like the mosquitoes which suck its blood and scavengers which eat its leftovers. This is the fundamental niche of the red fox. The fundamental niche is the complete range of biological and physical conditions under which an organism can live.

What has happened to the fundamental niche? The forest edge has been turned to farmland in many places. Some of the species eaten by the red fox have disappeared. The red fox must survive in a narrower range (p.560)

Biomagnification is a process by which chemical substances become more concentrated at each trophic level.

When chemicals are released into the environment they may be taken up by plants. The plants may not be affected by the small amount of chemical that they absorb or have on their surface. But when large amounts of affected plants are eaten by a primary consumer, the amount of chemical it takes in is much greater. Similarly, if numbers of the primary consumer are eaten by a secondary consumer, the amount of chemical taken in by the secondary consumer is magnified even more. Chemicals (p.579)

In an unstable environment, it is better to produce many offspring as quickly as possible. This is the r-strategy. In an unstable environment, lots of offspring are lost to unpredictable forces. The few that remain can reproduce and carry on the genes of the organism. You can imagine that weeds have this strategy. Weeds survive well in 'disturbed ground', like the side of a road that is constantly mowed or edge of a farm field or a drainage ditch. Weeds

produce thousands of seeds and grow quickly to take advantage of these unstable places. In sand dune succession, the plants (p.590)

APPENDIX C: Paragraphs from the IGCSE textbook

The most obvious interaction between different organisms in an ecosystem is feeding.

During feeding, one organism is obtaining food-energy and raw materials – from another one. Usually one organism eats another, but then may itself be food for a third species. The feeding relationships of the different organisms in the ecosystem can be shown in a food chain, as in the diagram below.

The amount of energy that is passed on in a food chain is reduced at every step. Since energy can be neither created nor destroyed, it is not lost but is converted into some other form.

During (p.232)

All living organisms depend on a supply of water, as we saw on page 244. Many organisms actually live in water. Most of these aquatic organisms respire aerobically and so require oxygen from their environment. Any change that alters the amount of oxygen in the water can seriously affect the suitability of the water as a habitat. The two pollutants that most often reduce oxygen in water are:

Fertilisers- nitrates and phosphates are added to soil by farmers (see page 256). Some of the fertiliser is washed from the soil by rain into the nearest pond, lake or river. (p.255)

Many small animals, particularly insects, cause a nuisance to humans because they bite or because they make food less palatable. More significant than their nuisance value, however, is the fact that they may transmit diseases to humans. Some of the diseases which can be passed from human to human in this way can be fatal.

An animal that transmits a pathogen (disease causing organisms) from one host to another is called a vector. The vector may transmit the pathogen either by carrying it on its body or by swallowing infected material. In the case of swallowed material – often blood- the (p.274)

APPENDIX D: Readability levels and readability results of the six selected textbooks

Readability Level	Readability Ease
Very easy	90-100
Easy	70-89
Moderate	50-69
Difficult	30-49
Very Difficult	1-29

(Ateşman, 1997)

Ateşman's formula = $198.825 - (40.175 \times X1 - 2.610 \times X2)$

X1= average word length in terms of syllable

X2= average sentence length in terms of word

MEB Grade 9	Number of Syllable	Number of Sentence	Word Length	Sentence Length	Readability Ease
Text 1	264	13	2.64	7.69	72.69
Text 2	335	8	3.35	12.5	31.61
Text 3	277	8	2.77	12.5	54.92
Total					53.07
MEB Grade 10	Number of Syllable	Number of Sentence	Word Length	Sentence Length	Readability Ease
Text 1	272	6	2.72	16.67	46.04
Text 2	283	10	2.83	10	59.03
Text 3	273	7	2.73	14.29	51.85
Total					52.31
MEB Grade 11	Number of Syllable	Number of Sentence	Word Length	Sentence Length	Readability Ease
Text 1	286	8	2.86	12.5	51.30
Text 2	325	10	3.25	10	42.16
Text 3	271	7	2.71	14.29	52.65
Total					48.70
MEB Grade 12	Number of Syllable	Number of Sentence	Word Length	Sentence Length	Readability Ease
Text 1	282	9	2.82	11.11	56.53
Text 2	264	6	2.64	16.67	49.25
Text 3	293	9	2.93	11.11	52.65
Total					52.07

Flesch's Readability formula = $206.835 - (1.015 \times ASL) - (84.6 \times ASW)$

ASL = Average sentence length

ASW = Average number of syllables per word

IBDP/Topic 5	Number of Syllable	of	Number of Sentence	of	Word Length	Sentence Length	Readability Ease
Text 1	158		7		1.58	14.29	58.7
Text 2	146		5		1.46	20	63
Text 3	155		6		1.55	16.67	58.8
Total							60.17
Option G	Number of Syllable	of	Number of Sentence	of	Word Length	Sentence Length	Readability Ease
Text 1	133		9		1.33	11.11	83
Text 2	160		6		1.6	16.67	54.6
Text 3	138		8		1.38	12.5	77.4
Total							71.67

IGCSE	Number of Syllable	of	Number of Sentence	of	Word Length	Sentence Length	Readability Ease
Text 1	154		7		1.54	14.29	91
Text 2	151		6		1.51	16.67	62.2
Text 3	149		6		1.48	16.83	64.9
Total							72.7

APPENDIX E: Interview questions

Content

1. What do you think about the alignment with curriculum requirements of textbooks?
2. What is your opinion about level of treatment of textbooks in terms of objectives, students and time?
3. Does the content of textbooks include necessary information about authorship and sources?
4. How do textbooks cover ecology units in terms of objectivity, representativeness and correctness? Did you realize any falsity? If so, what are those falsities?
5. How well are ecology units of textbooks current?
6. What do you think about authenticity of content?
7. What do you think about multicultural representation of textbooks?
8. How do you evaluate ecology units of textbooks in terms of humanity and compassion?

Presentation

1. How well is the comprehensiveness of student and teacher resources?
2. What do you think about alignment of instructional components?
3. How well is the organization of textbooks?
4. What do you think about logical organization of textbooks?
5. What do you think about the readability of textbooks?
6. How well is the pace of content of textbooks?
7. What do you think about ease of use of textbooks?

Learning

1. What do you think about motivational strategies of textbooks?
2. How well do textbooks teach a few big ideas?
3. What do you think about explicit instructions?
4. How well do textbooks provide guidance and support?
5. What do you think about active participation strategy of textbooks?
6. How well are instructional strategies and assessment techniques of textbooks?
7. What do you think about targeted instructional and assessment strategies of activities in textbooks?