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Comparing biodiversity-related contents in secondary biology textbooks from Korea, Indonesia, and the USA

한국, 인도네시아, 미국 생물 교과서의 생물 다양성 관련 내용 비교

2020 년 2 월

서울대학교 대학원

과학교육과 생물전공

사 키 르

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2019 년 12 월

서울대학교 대학원

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사키르의 석사 학위논문을 인준함

2020 년 1 월

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ABSTRACT

Comparing biodiversity-related contents in secondary biology textbooks from Korea, Indonesia, and the USA

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Representative biology textbooks for secondary school students from Korea, Indonesia, and the USA were compared to explain the differences among each country's biodiversity-related contents. For comparison, a specialised technical book was added as a reference book. Textbooks from Korea, Indonesia, and the USA have similar main sub-sections of biodiversity contents. However, both Indonesian and American biological textbooks have special additional sub-sections that differed from Korean textbook. However, none of these biological textbooks presented fully similar explanation with the reference book as a standard. Since there were several differences in explaining major topics of biodiversity in each country, suggestion was made for curricula compilers to adapt provided biodiversity related-contents for

presenting the contents better in the future. In addition, biology textbook authors in Korea should add more native biological diversity examples in biodiversity content especially in conservation sub-section. With this, hopefully students can learn and know more their countries' biodiversity richness through biological textbook.

Keywords: Biodiversity; biology textbook; conservation; curriculum; native species; non-native species

Student Number: 2018-28593

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I. INTRODUCTION

During the last few decades, an increasing awareness has been raised that human biodiversity remains to be the one of the most critical challenges in the twenty-first century (Butchart et al. 2010). Along with the challenge of climate change, the loss of biodiversity is humanity's main battleground for sustainability. Biodiversity loss is occurring in daily basis and accelerating in the face of population growth, climate change, and rampant development (Sandifer, Grier, and Ward 2015). To assess global biodiversity loss, ecologists have proposed classes of 'essential biodiversity' including species trait, populations, and function and structure of ecosystem (Bull et al. 2010).

Biodiversity is important in scientific learning since humans concerned about biodiversity issues due to undeniable evidence of significant global declines. In line with this, to protect and preserve the Earth's biodiversity as much as possible has been a fundamental goal of conservation. This is a formidable challenge given the current and projected rates of global biodiversity loss is significant. This challenge is exacerbated when the need to protect biodiversity conflicts with the needs of people (Wiens, Fargione, and Hill 2011). Biodiversity conservation has increasingly gained recognition in national and international agendas (Perez and Tidball 2012). Understanding biodiversity and its important can be assisted by comprehending the range of distinctive values that individuals and societies may assign to the living world and the ecosystems that it comprises (UNESCO 2017).

Education has been acknowledged as an important tool to achieve sustainability as well as biodiversity protection through the transformation of human attitudes towards nature (Ehrlich and Pringle 2008). In this sense, there are great opportunities for education to

contribute by helping citizens become well informed, critical and competent, and in consequence, able to act in favour of biodiversity. Promoting students' commitment to protect local biodiversity is an important goal of education for sustainable development in elsewhere (Ramadoss and Moli 2011). Textbook is a primary media used in the learning process. Hence, it is important to review how biology textbooks explain biodiversity related contents. Nevertheless, studies about how biodiversity contents are explained in biology textbook are relatively fewer than other concepts. Different political, institutional, technical, societal and educational factors have been recognised as obstacles for the implementation of the Convention on Biological Diversity, such as institutional weakness, lack of political will lack of mainstreaming and integration of biodiversity issues into different sectors, lack of financial and human resources as well as lack of public education and awareness, among others (Convension on Biological Diversity 2010).

Biodiversity education also seems to share common goals with what has been conceived as conservation education. Jacobson, McDuff, and Monroe (2006) have argued that conservation education shares many goals with environmental education. Conservation education shares many goals with environmental education. For example, both educations intend to help learners gain awareness and sensitivity, knowledge and basic understanding of the environment. Moreover, they also direct learners to gain attitude that derive from a set of values and feelings concerning environment which can lead to its protection, and skills that allow individual to identify and solve environmental issues. They have also recognised conservation education shares goals with Education for Sustainable Development in that both intend to protect environmental systems to sustain life while accounting for social justice

and ensuring proper economic development (Jacobson, McDuff, and Monroe 2006). However, there still lack of research which specifically study about biodiversity content in environmental education. Therefore, in this study I intended to analyse biodiversity related contents presented in biology textbook.

Biology textbooks from three countries (Korea, Indonesia, and the USA) were selected as research sample due to several considerations; The Organisation for Economic Co-operation and Development (OECD) released results of 2015 global rankings on student performance in mathematics, reading, and science based on the Programme for International Student Assessment (PISA). Based on that result, Korea placed the top 11st of 2015 PISA average scores on science. Meanwhile, the United States of America was in the 25th place on the list, even though the USA was ranked as the most developed countries in the world based on Human Development Index. Indonesia was in the 62nd place on the list of science performance ranked, is one of the countries in the world that has high biodiversity. Conservation International considers Indonesia to be one of the 17 'megadiverse' countries, with two of the world's 25 'hotspots', 18 World Wildlife Fund's 'Global 200' ecoregions and 24 of Bird Life International's 'Endemic Bird Areas'. Moreover, a specialised technical book was chosen as a guideline for standard contents of biological diversity to compare textbooks from Korea, Indonesia, and the USA.

The general goal of this study is to get an idea in revising national curriculum of three countries related to biodiversity contents. Meanwhile the specific objectives was to compare the presentation of the main contents related to biodiversity in biology textbooks from Korea, Indonesia, and the USA, compare the amount of native and non-native biological diversity in these textbooks, and to explore what types

of information about local biological diversities were presented. Therefore, there were three objectives:

1) To provide comparison data of biodiversity related contents presented in biology textbook from Korea, Indonesia, and the USA.
2) To compare the prevalence of the native and non-native biological diversity presented in the textbooks.
3) To compare the information of biodiversity content in each sub-sections presented in the textbooks.

I hypothesised that the biology textbooks from three countries would have similar categorization of topics or sub-sections of biodiversity content but have different presenting style. Given the cultural context in which textbooks were created, we hypothesised that native biological diversity presented in Indonesian biology textbook would be prevail over the two other countries.

II. MATERIALS AND METHODS

2.1 Research samples

In this study, representative biology textbooks from Korea, Indonesia, and the United States of America (USA) were examined. These biology textbooks are known to be popular textbooks in each country and are commonly used in both public schools and private schools. Biology for NGSS book from the USA published by Biozone is distributed and used in English-speaking world, such as Australia, United Kingdom and New Zealand. Award from Association of American Publishers (AAP) honours Biozone as International for excellence of educational product. Visang (비상) publisher was considered to be a historical publishing house for biology textbook in Korea. In 1997, Visang was established in Korea as educational publishing company, and its textbook publications began to be used by school practitioners and received many awards from various organisations nationally and internationally. In 2006, it was selected as 'Best Human Resource Development Organisation' by Korea Management Association Consulting. Meanwhile, Erlangga publisher from Indonesia continuously received the prestigious award of Top Brand for teens in 2018, which is the sixth award (2013–2018) for 'Education Book' category and awarded as 'The Best Educational Book in Indonesia'. This award certainly confirms the existence of Erlangga Publisher in the education field that has a prestige image among Indonesians. For these reasons, I then selected these biology textbooks as samples in this study.

Moreover, all selected textbooks were the newest revised version based on the newest national curriculum in each country. The American textbook is based on K-12 science instruction. The Korean biology textbook is based on curriculum 2015 and Indonesian biology textbook is based on curriculum 2013. Furthermore, these textbooks

were published in the recent years (Table 1). For comparison, a specialised technical book was added as a reference book in this study. This book contains full of ecology sections including biodiversity related contents. The authors of this book are well known as environmentalists who conducted numerous researches and wrote books related to biodiversity and conservation biology. Thus, I picked this book as specialised technical book for reference.

2.2 Textbook structure and units of study

I analysed biology textbooks from three countries to explore and compare how biodiversity related contents were presented. Each textbook consisted of several chapters which consist of diverse biology contents. My study examined only biodiversity concerned chapter of each textbook. Within the chapter, there were lesson title pages, key idea boxes, key term boxes, paragraphs, illustrations, individual activity boxes, photographs and chapter assessments. I limited my data collection to the paragraphs of information and photographs. Therefore, this analysis excluded key idea and term boxes, illustrations, individual activity boxes and chapter assessments. Moreover, I selected the subtitled sections that we called as sub-sections, which included the biodiversity term in its title.

Table 1. Information of the biology textbooks of three countries that examined in the present study

Nation	Textbook title	Publisher	Authors	Published Year
Korea	생명과학 I (Biological Science I)	비상 (Visang)	Shim et al.	2018
Indonesia	Biologi untuk SMA/MA Kelas X	Erlangga	Irnaningtyas	2016
The USA	Biology for NGSS (2nd edition)	Biozone	Greenwood et al.	2016
Reference book (Specialised technical book)	Biodiversity: An Introduction	Blackwell Publishing	Gaston and Spicer	2004

2.3 Data collection

2.3.1 Biodiversity sub-section

To analyse the major biodiversity topics of the chapters, I created a categorisation that would correspond to the topics found in the textbooks. Since there was no previous research about the categorisation of sub-section of biodiversity contents in the textbook, I adapted an inductive approach used by Schussler et al. (2010) to categorise the sub-section in the textbook. Overall, the three textbooks from Korea, Indonesia, and the USA had a similar major categorisation of topics (sub-sections). However, there were few special or additional sub-sections that were in only one or two countries' textbook. In this case, I created the main sub-section categories which are presented in all three countries' textbook and the special sub-section categories which included the sub-sections that were partially presented. I sorted

all sub-sections and categorised the main sub-sections into definition, level, value, cause of loss, and conservation of biodiversity; while special sub-section categorisation into biodiversity measurement, hotspot and local biodiversity. I scanned the information (explanation and description) that included into all sub-sections and compared each of them to other textbooks and technical reference book.

2.3.2 Amount of biological diversity presented

I specifically intended to compare the amount of native and non-native biological diversity mentioned in each textbook. Data that I collected were the biological diversity examples' information and photograph used in the textbooks. The scope of this data included main and special subsections and also the frequency of biological diversity presented in the textbooks. To collect data, the text of each native and non-native biological diversity mentioned in the textbook was recorded.

III. RESULTS AND DISCUSSION

3.1 Sub-sections of biodiversity presented in the textbook

I created a categorisation of sub-sections of biodiversity contents and divided them into main and special sub-section. The three textbooks from Korea, Indonesia, and the USA included the main sub-sections of biodiversity contents, even though there were special sub-sections in Indonesian and American textbook that were not found in Korean textbook (Table 2). The explanations of all sub-sections will be shown in discussion section of this study. As well as the comparison of all biodiversity contents in three textbooks from Korea, Indonesia, the USA, and the technical reference book will be further elaborated.

Table 2 **.** Sub-sections of biodiversity presented in the three textbooks (O = present of sub-section contents; X = absent).

	Sub-section		Country of the Textbook		
			Korea	Indonesia	The USA
Main	Definition of biodiversity		O	O	O
	Level of biodiversity	Genetic	O	O	O
		Species	O	O	X
		Ecosystem	O	O	O
	Biodiversity value		O	O	O
	Cause of biodiversity loss		O	O	O
	Biodiversity conservation		O	O	O
Special	Biodiversity measurement		X	X	O
	Biodiversity hotspot		X	X	O
	Local biodiversity		X	O	X

To give an illustration on how the biodiversity contents were presented in each textbook, I drew conceptual maps of sub-sections of biodiversity. The contents of biodiversity in Korean textbook were divided into three sub-sections (definition, value, and conservation). The definition was presented in general, and also it included the level of biodiversity (genetic, species and ecosystem diversity). The value of biodiversity was presented separately in several sub-sections, while cause of biodiversity loss content was incorporated into biodiversity conservation subsection (Figure 1a). There were five major sub-sections of biodiversity presented in Indonesian textbook; definition, level, ecosystem type, biodiversity of Indonesia and conservation (Figure 1b). In contrast to Korean textbook, the value of biodiversity in Indonesian textbook was described in 'biodiversity of Indonesia' sub-section. In American textbook, the content structure of biodiversity was divided into six sub-sections; definition, diversity measurement, humans depend on biodiversity, hotspot, conservation, and how humans affect biodiversity (Figure 1c). However, species diversity content was not included in this textbook.

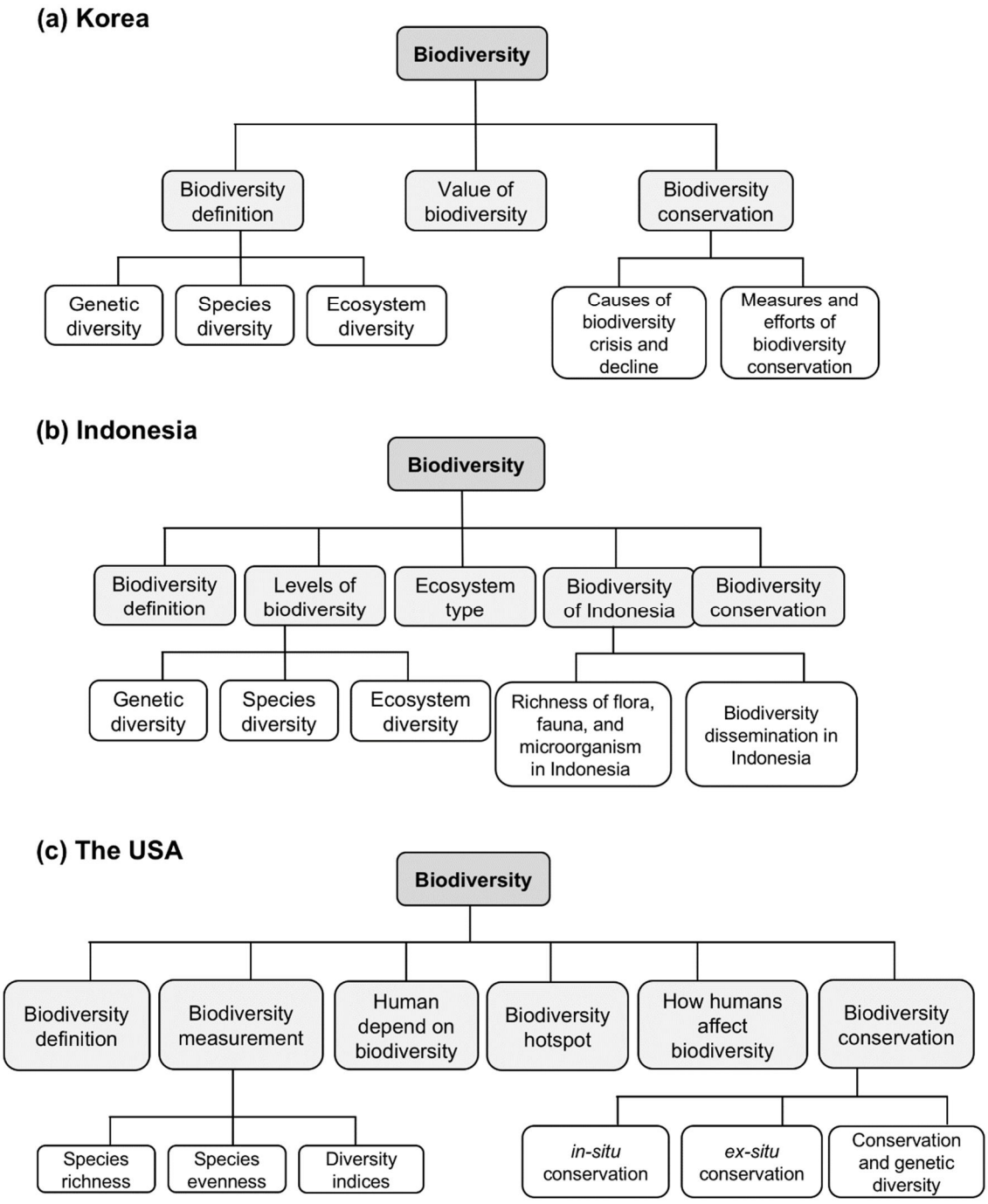

Figure 1. Concept map of biodiversity sub-sections presented in **(a)** Korean, **(b)** Indonesian, and **(c)** American biology textbook.

3.2 Amount of native and non-native biological diversity mentioned in the textbook

The number of native and non-native species used within the sub-sections differed in each textbook from Korea, Indonesia, and the USA (Figure 2a). There were more non-native than native biological diversity species examples in Korean textbook. There were only two native species mentioned in the textbook as compared to seven non-native species. In Indonesian textbook, huge number of native species were mentioned. The number of native species was higher than non-native species. For the entire biodiversity chapter in Indonesian textbook, there were a total of 69 native species versus 40 non-native species examples. Furthermore, a different result was found in the USA textbook. There was an equal number of native and non-native biological diversity species presented in the textbook. Both native and non-native species had nine examples mentioned in the textbook.

These data supported my hypothesis that there would be a greater amount of native and nonnative species presented in Indonesian biological textbook than Korean and the USA textbooks. Also, our analysis of the number of native and non-native biodiversity species found that both native and non-native species mentioned was prevailed in the Indonesian textbook. The number of species mentioned in each sub-section in Korean textbook is shown in Figure 2b. There were no any species presented as an example in definition and level of biodiversity sub-sections. One non-native species (Gossypium sp.) was mentioned in biodiversity value sub-section. The same numbers of native and non-native species were presented in the cause of biodiversity loss sub-section. For conservation sub-section, I found five non-native species mentioned in the textbook as compared to only one native species in Korean textbook. There were much more native

species examples (24 species) presented in value and conservation of biodiversity sub-section in Indonesian textbook than there was about non-native species (14 and 19 species). Moreover, the number of native and non-native species mentioned in definition, level, and cause of biodiversity loss ranged from 1 to 8 species (Figure 2c). In American textbook, the mentioned native and non-native species were equally distributed in conservation and hotspot subsection, four and five species respectively (Figure 2d).

Primack (2013) pointed out the valuable step to develop biodiversity conservation comprehensions is to involve local content in the science textbook. The limited exposure of native species presented in Korean textbook may affect students' ability to learn the endemic species that exist in their country. The native species were repeatedly mentioned in different sub-sections, while the majority of nonnative species presented in Korean textbook are originally native to the USA. Otherwise, in Indonesian textbook, much more native species were mentioned than non-native species. It provided many examples of species which are distributed over archipelagoes in Indonesia. It appears that the science curricula in Indonesia intended to introduce the local biodiversity to students through learning media (textbook). However, there is no study about how high number of native species mentioned in the textbook can increase students' knowledge of biodiversity. The American textbook used more nonnative species than native species as examples, even though the numbers were not too much different.

Textbook could assist student in learning and encourage them to get closer about biodiversity especially native species. In this case, I predict that the more students know about biodiversity species (native and non-native), the more their willingness to take a part in

conservation efforts. I argue that integrating more native species examples into biological textbook is most likely can be helpful for students in understanding the existences of local biodiversity in their country. In addition, it could be useful also in constructing student's attitudes towards biodiversity, acquaint with the local biodiversity problems, and create an interest to participate in biodiversity conservation effort.

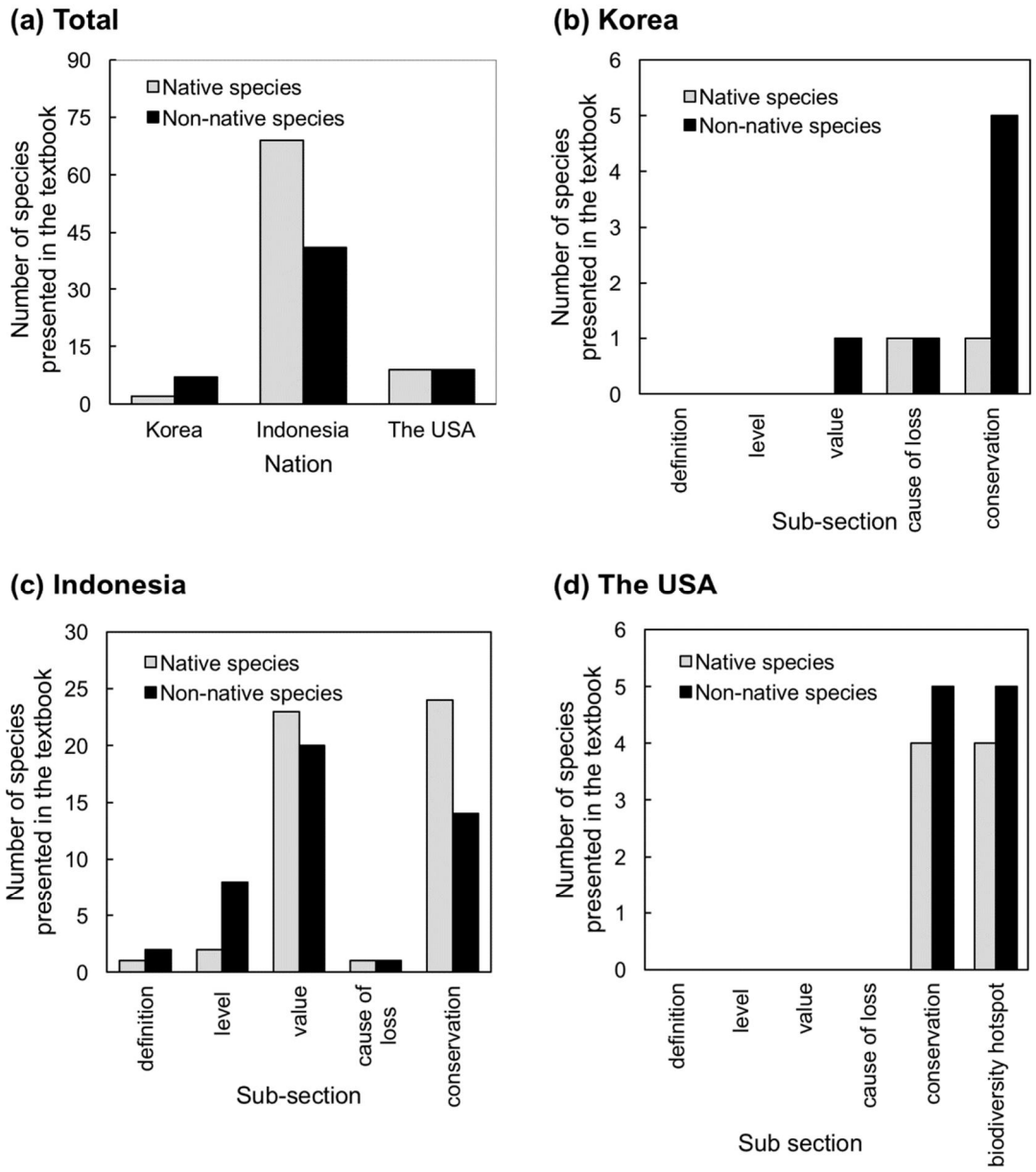

Figure 2. Number of native and non-native species which were presented in biology textbooks from three nations. **(a)** Overall number of native and non-native biodiversity species examples used within each textbook. **(b-d)** The number of native and non-native biodiversity species presented in each sub-section in **(b)** Korean, **(c)** Indonesian, and **(d)** American textbook.

3.3 Comparing the information of biodiversity content in each sub-sections presented in the textbook

3.3.1 Biodiversity definitions in biology textbooks

Biodiversity definition in biology textbooks from the three nations did not cover all sources of biodiversity as the stated definition (Table 3). These definitions were referred to as levels of biodiversity (genetic, species and ecosystem) without mentioning where organisms belong to. Most straightforwardly, biological diversity or biodiversity is 'the variety of life' (Gaston and Spicer 2004). It collectively refers to variation at all levels of biological organisation. In the reference book, Biodiversity: An Introduction, it explained that many formal definitions of biological diversity or biodiversity have been proposed to develop a simple one. Of these definitions, perhaps the most important and far-reaching definition is the one contained within the Convention on Biological Diversity (Convension on Biological Diversity 2010). This landmark treaty was signed by more than 150 nations on 5 June 1992 at the United Nations Conference on Environment and Development, held in Rio de Janeiro. It came into force approximately 18 months later. However, none of the biology textbooks from the three countries explained biodiversity definition based on what the convention released. The latest stated definition in the table can be used as a standard or primary term for general biodiversity definition in biology textbook worldwide, including biology textbook in Korea, Indonesia and the USA.

In contrast to the other two textbooks, Korean textbook explained in definition that biodiversity is an indicator of the ecosystem health. Biodiversity has key roles at all levels of the ecosystem service hierarchy (Mace, Norris, and Fitter 2012) and biological diversity benefits the ecosystem health in small and natural communities to

larger landscape over long periods (Lasnier 2013). In this respect, other textbooks should include the relation between biodiversity and ecosystem health.

Table 3. Biodiversity definition presented in biology textbooks from Korea, Indonesia, and the USA.

Textbook	Definition
Korea (Shim et al., 2018)	생물 다양성이란 유전적 다양성, 종 다양성, 생태계 다양성을 모두 포괄하는 개념으로, 생태계 의 건강한 정도를 판단하는 지표가 된다. (Biodiversity is a concept that encompasses genetic diversity, species diversity, and ecosystem diversity, and is an indicator of the health of an ecosystem)
Indonesia (Irnaningtyas, 2016)	Biodiversitas adalah variasi organisme hidup pada tiga tingkatan yaitu tingkat gen, species, dan ekosistem. (Biodiversity is variations of living organisms at three levels; genes, species, and ecosystems)
The USA (Greenwood et al., 2016)	Biodiversity is the amount of biotic variation within a given group. It could be the number of species in a particular area or the amount of genetic diversity in a species.
Reference book (Gaston and Spicer, 2004)	Biological diversity means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.

3.3.2 Level of biodiversity presented in textbooks

Biology textbooks from Korea and Indonesia present that there are three levels of biodiversity: genetic diversity, species diversity and ecosystem diversity (Table 4). In line with this, in the reference book, the three major components of the earth's biodiversity are genetic,

species and ecosystem. Genetic diversity in the Korean textbook refers to the presence of various alleles in a species. In other words, more diversities of alleles indicate higher genetic diversity of the species. Its example is giraffe. Although, they belong to the same species, they have different hair patterns. Meanwhile, in Indonesian biology textbook, genetic diversity is defined as variations or gene differences occurring within a species or species of living things. Its example is durian (*Durio zibethinus*) which has different fleshy fruit.

Nevertheless, the USA biology textbook does not present the biodiversity structurally into three levels. It merely lists about the biodiversity of earth, the type of organism (protozoa, brown algae, invertebrates, plants, fungi, vertebrates), and estimate number of species of these organisms on earth. It does not explain explicitly about the type of biodiversity like the textbook from Korea or Indonesia. However, in the USA textbook, it presented the way to measure biodiversity. One measure of biodiversity is to simply count all species present (species richness), although this may give an imprecise impression of the ecosystem's biodiversity.

Species diversity in Korean textbook mentioned species richness and evenness. Species richness is the number of species in the community while species evenness is the number of species in the community. Indonesian textbook explains species diversity as a distinction that can be found in communities or groups of species that live in certain location. Meanwhile, the American textbook does not explain about species diversity definition. However, it presents data of hotspot where biodiversity tends to be clustered in certain parts of the world where species diversity is high.

Ecosystem diversity contents are presented in all textbooks. Moreover, Korean and Indonesian textbooks explained its concepts by

presenting categorisation of ecosystem where ecosystems are divided into terrestrial ecosystem (forests, meadows, tundra) and aquatic ecosystems (freshwater and marine). Meanwhile, in the USA textbook, ecosystem diversity concept is followed by the explanation that the perception of an ecosystem's diversity may differ depending on how the biodiversity is measured. Tropical forests and coral reefs are examples of some of the most diverse ecosystems on earth.

Table 4. Level of biodiversity presented in biology textbooks from Korea, Indonesia, and the USA.

Textbook	Kind of biodiversity	Definition
Korea (Shim et al., 2018)	Genetic diversity	유전적 다양성은 생물종에 얼마나 다양한 대립유전자가 존재하는가를 뜻한다. 즉, 대립유전자의 종류가 다양할수록 생물종의 유전적 다양성이 높다고 할 수 있다 (Genetic diversity refers to the presence of various alleles in a species. In other words, the more diversity of alleles, the higher the genetic diversity of species).
	Species diversity	종 다양성은 어느 한 군집에 서식하는 생물종의 다양한 정도이며, 종풍부도와 종 균등도를 모두 고려하여 나타낸다 (Species diversity is the degree of diversity of species in a community and is based on both species richness and species evenness).
	Ecosystem diversity	생태계 다양성은 생물 서식지의 다양한 정도이다 (Ecosystem diversity is a variable degree of biological habitat).
Indonesia (Irnaningtyas, 2016)	Genetic diversity	Variasi atau perbedaan yang terjadi dalam suatu jenis species makhluk hidup (The variation or the difference occurred within species of living things).
	Species	Perbedaan yang dapat ditemukan pada

	diversity	komunitas atau kelompok berbagai species yang hidup disuatu tempat (The difference that can be found in communities or groups of various species which live in a place).
	Ecosystem diversity	Ekosistem terbentuk karena berbagai kelompok species menyesuaikan diri dengan lingkungannya (Ecosystem are formed because the different groups of species adapt with their environment)
The USA (Greenwood et al., 2016)	Genetic diversity	The diversity of genes and alleles within a species
	Species diversity	-
	Ecosystem diversity	Ecosystem diversity refers to the number of ecosystems in a given region and is usually correlated with species diversity.
Reference book(Gaston and Spicer, 2004)	Genetic diversity	Genetic diversity encompasses the components of the genetic coding that structures organisms (nucleotides, genes, chromosomes) and variation in the genetic make-up between individuals within a population and between populations.
	Species diversity	Species diversity encompasses the taxonomic hierarchy and its components, from individuals upwards to species, genera and beyond.
	Ecosystem diversity	Ecological diversity encompasses the scales of ecological differences from populations, through niches and habitats, on up to biomes. Although presented separately, the groups are intimately linked, and in some cases share elements in common (e.g. populations appear in all three).

The standard of biodiversity levels can refer to the reference book which describes levels of biodiversity generally into three levels (genetic, species and ecosystem). As prior explanation, biology

textbooks from Korea and Indonesia have divided biodiversity into three levels. Meanwhile, the biology textbook from the USA did not present an explanation about biodiversity levels. Therefore, it should refer to the standard so that three levels of biodiversity can be included in biodiversity contents of biology textbook.

3.3.3 Biodiversity values

Biology textbooks from the three countries mainly explain values of biodiversity values that can give benefits to humans such as for consumption, health, biological resources and cultural (Table 5). These values of biodiversity are broadly beneficial for human needs, such as biological, social and cultural values. However, none of three biology textbooks explains how the entire biodiversity in this world can contribute and give some direct and indirect values for human. Other values such as moral, social and religious values should be included in biology textbook from the three countries depending on how each nation interprets and interlinks these values to biodiversity.

Indonesia as one of megadiverse countries in the world presented only one subunit to explain about local Indonesian biodiversity. It consisted of flora, fauna and microorganism diversity in Indonesia, distribution of biodiversity in Indonesia, and the function and benefits of biodiversity in Indonesia. In this sub-section, students may learn that Indonesia is a country with high biodiversity in that there are many kinds of species that are distributed in thousands of islands. It described that, although the land area of Indonesia is just 1.3% from the total land area in the world, many species in the world exist in Indonesia. Nevertheless, it is necessary to link biodiversity distribution in Indonesia to hotspot of biodiversity as where Indonesia is one of the hotspot regions in the world. Furthermore, values of Indonesian

biodiversity mentioned below merely presents local species values in Indonesia (Table 5).

Table 5. List of biodiversity values in biology textbooks from Korea, Indonesia, and the USA.

Textbook	Biodiversity values
Korea (Shim et al., 2018)	Foods, medicines, valuable biological resources, clothing, relaxing and cultural space.
Indonesia (Irnaningtyas, 2016)	As foods, medicine, cosmetic, clothing, cultural value, germplasm.
The USA (Greenwood et al., 2016)	Food, fuel, purification of the air and water, building materials, cultural services.
Reference book (Gaston and Spicer, 2004)	Survival (natural living conditions for mankind and other organisms, multiplicity of foodstuffs for all beings), health and economic well-being (supply of substances for medicines and other products, local economies and social structures), socio-cultural (sustaining the space we live in, homeland and cultural identity), sensory and aesthetic appreciation of nature, religious-contemplative experiences with regard to nature and its regime, research and knowledge pools.

Certainly, exploring such issues has attracted the attentions of generations of natural historians, palaeobiologists and ecologists (Gaston and Spicer 2004). However, it ignores a fundamental question that demands both an intellectual and a practical response. Does biodiversity matter? The values of biodiversity can be divided into two broad and largely self-explanatory groups: use values and non-use values. These categories are not always clear-cut, but they are still helpful as long as one is mindful of their limitations. The use value of biodiversity is divided into two major components of direct-use and indirect use value. Therefore, the sequence and categorisation in which

these values are presented in the reference book can be adapted by textbook authors of each country, since none of them divided the categorisation of biodiversity values into below categories.

3.3.4 Cause of biodiversity crisis and decline

Loss of biodiversity is a worldwide concern (Krauss et al. 2010). There are many causes of biodiversity crisis and decline. Biology textbooks from the three countries mainly presented humans behavior as a factor of biodiversity crisis (Table 6). The textbook from Korea explains that the most common cause of biodiversity decline is habitat destruction due to forest fires and reclamation of wetlands. Habitat fragmentation, where ecosystems are divided into small ecosystems by road construction, residential land development, and industrial complex construction can also reduce biodiversity. In Indonesian textbook, it explains that, based on data from IUCN (International Union for Conversation of Nature), the main factor of biodiversity loss is unsustainable agriculture and forest management. Meanwhile, the textbook from the USA emphasises global warming as a significant contributor to loss of biodiversity. It presented its evidence indicating that human activities, particularly deforestation and the use of fossil fuels, are responsible for the current climate change. This global warming will change habitats throughout the world.

Based on information provided in Table 6, textbook from the USA should present other causes of biodiversity crisis and decline. Gaston and Spicer (2004) explain that species losses, and other declines in biodiversity have four main causes: (1) direct exploitation; (2) habitat loss and degradation; (3) introduced species; and (4) extinction cascades. These have been termed ‘the evil quartet’ (Diamond 1984). Whilst reasonably well characterised, patterns and rates at which these drivers are changing are less well understood.

Table 6. List of causes of biodiversity crisis and decline in biology textbooks from Korea, Indonesia, and the USA.

Textbook	Cause of biodiversity crisis and decline
Korea (Shim et al., 2018)	Habitat destruction and fragmentation, illegal fishing and over fishing, environmental pollution, invasion of alien species.
Indonesia (Irnaningtyas, 2016)	Habitat loss, environmental pollution (soil, air, and water), climate change, plant and animal exploitation, the existence of alien species, industrialization of agriculture and forests.
The USA (Greenwood et al., 2016)	Global warming, coral bleaching, land use.
Reference book (Gaston and Spicer, 2004)	Direct exploitation, habitat loss and degradation, introduced species, and extinction cascades.

3.3.5 Biodiversity conservation

Conservation content is considered important and should be explained in biology textbook. In Korean biology textbook, the content about biodiversity conservation did not explain the definition or the type of conservation (ex-situ and in-situ). However, some examples of biodiversity conservation efforts (national and international) in Korea were presented. For example, national scale of Wildlife Protection and Management Act is established to prevent extinction of wildlife. Jirisan is designated as a national park, Korea is internationally engaged in biodiversity preservation activities by joining the biodiversity convention. Meanwhile, the biology textbook from Indonesia and the USA explained about the types of biodiversity conservation and provided several samples (Table 7).

The biodiversity narrative needs to be broaden and resonate with all society. It must expand from treating biodiversity solely as an environmental concern to recognising that biodiversity is essential to sustainable development and opportunity and necessity for humans (Palmer 2019). Conserving biodiversity enables the protection and sustainable provision of ecosystem goods and services. Likewise, maintaining ecosystem health can be used to strengthen the conservation of biodiversity (Egoh et al. 2009). Rands et al. (2010) argued that effective conservation of biodiversity is essential for human survival and the maintenance of ecosystem processes. Biodiversity education becomes necessary to educate students and promote the awareness on biodiversity conservation (Jiwa and Esa 2015). Therefore, conservation content is considered important and should be well explained in biological textbook.

Table 7. Types of biodiversity conservation in biology textbooks from Korea, Indonesia, and the USA.

Nation	*ex-situ*		*in-situ*	
	Definition	Example	Definition	Example
Korea (Shim et al., 2018)	-	Wildlife protection and management act	-	National park
Indonesia (Irnaningtyas, 2016)	Conservation effort undertaken outside of its original habitat.	Botanical garden, a safari park, a collection garden, or a zoo.	Conservation effort undertaken in its natural habitat.	Nature reserve, national park, wildlife reserve, forest park, marine park.
The USA (Greenwood et al., 2016)	Off-site conservation.	Captive breeding and relocation, the important role of zoos and aquaria, the role of botanic garden, seed banks and gene banks.	Conservation of species in its natural environment.	Returning bison the wild
The Reference book (Gaston and Spicer, 2004)	Conservation held in such facilities (out of natural habitat)	Seed banks, sperm and ova banks, culture collections (e.g. of plant tissues), artificial propagation of plants and captive breeding of animals.	Conservation occur in the wild (natural habitat).	20,000 existing protected areas, spread amongst virtually all countries in the world.

Major advances in the two main complementary strategies for biodiversity conservation, namely ex situ and in situ, over the last decade are presented to reflect on their current global status and trends (Dulloo, Hunter, and Borelli 2010). Due to the absence of biodiversity methods explanation in biology textbook from Korea, the content of biodiversity conservation definition and its type should be presented in Korean textbook. It can refer to the general concept that biodiversity conservation commonly has two methods (ex situ and in situ). However, some examples of biodiversity conservation efforts (national and international) in were presented. For example, national scale of Wildlife Protection and Management Act is established to prevent extinction of wildlife. Jiangsu is designated as a national park, Korea is internationally engaged in biodiversity preservation activities by joining the biodiversity convention. Regardless the presentation of these conservation examples, the definition of conservation categories should be included in Korean textbook. This can help students to figure out the categorisation of conservation, as well as the definitions. Meanwhile, the textbooks from Indonesia and the USA presented the types of biodiversity conservation and its definitions, and providing several samples (Table 7). Compared to reference book, both Indonesian and American textbook explained the similar concept of ex-situ and in situ conservation: ex situ occur outside of natural habitat, whereas in situ held in the natural habitat.

3.4 Special sub-section

Sub-contents that are only presented in the biology textbook of the USA are biodiversity hotspot, biodiversity measurement, and conservation genetics (Table 8). These contents are considered

important because it can provide a general information to students. Biodiversity is not distributed evenly on earth. It tends to be clustered in certain parts of the world, called biodiversity hotspot (Greenwood et al. 2016). These are biologically diverse and ecologically distinct regions which are under the greatest threat of destruction from human activity nowadays. They are identified by the number of species present, the amount of endemism (species unique to a species geographic location), and the extent to which species are threatened.

Biodiversity is measured for a variety of reasons, e.g. to assess the success of conservation work or to measure the impact of human activity. Species evenness gives a measure of relative abundance of species, i.e. how close in numbers the different species in an environment are. It describes how biodiversity is apportioned. Furthermore, conservation genetic is well presented in USA biology textbook. In the textbook, it explains that conservation genetics is an important concept for conservation and breeding programmes. By keeping detailed breeding records of which species are bred together and monitoring genetic relatedness of populations, conservation scientists can make sure that endangered species avoid inbreeding depression and maintain their genetic diversity. Conservation genetics is a broad field with many different areas, ranging from phenotypic effects of inbreeding to the use of genetic markers for identity.

Table 8. List of contents presented only in the USA biology textbook (Greenwood et al., 2016).

List of Contents	Descriptions
Biodiversity hotspot	Biodiversity is not distributed evenly on earth. It tends to be clustered in certain parts of the world.
Measuring biodiversity	Consist of species richness, species evenness, and diversity indices. Species richness is a simple method of estimating biodiversity in which the number of species is counted. Species evenness is a method in which the proportions of species in an ecosystem are estimated. Meanwhile, diversity indices use mathematical formula based on the species abundance and the number of each species to describe the biodiversity of an ecosystem.
Conservation genetics	Involves many branches of science and uses genetic methods to restore genetic diversity in a declining species.

Indonesian textbook presented 'Biodiversity of Indonesia' as special sub-section which was incorporated with the values of biodiversity sub-section. In this sub-section, the biological diversity, which exist in Indonesia were presented, ranged from flora, fauna and microorganism diversity. The distribution of biodiversity in the five largest islands of Indonesia was also presented. I indicated cultural, ethical, and religion aspects were linked to biodiversity in this sub-section. For instance, traditional costume of native inhabitants of Papua (formerly Irian Jaya) called 'Koteka' and 'Rumbai' are made of plant

material (Imperata cylindrica). Traditional house in certain regions of Indonesia is also made from wood material.

IV. CONCLUSION AND SUGGESTIONS

Overall, I found that although Indonesian and American biological textbooks have special additional sub-sections that differed from Korean textbook, all of them have identical main sub-sections of biodiversity contents. However, the explanation presented in each textbook was not really matched to the explanation in the reference book. In Korean textbook, there was no special or additional content and the definition of conservation. In Indonesian textbook, the content that related to biodiversity measurement was not provided. Meanwhile, in American textbook, there was no explicit explanation about species diversity. Therefore, I suggest that curricula compilers in three nations use these data to present better biodiversity related-contents in the near future. Due to the less prevalent native species presented in Korean textbook, I recommended to biology textbook authors or science curricula in Korea to append more native biological diversity examples in biodiversity content especially in conservation sub-section. Finally, through this study, the sustainable biodiversity knowledge will be achieved, and I hope students can be motivated to protect and conserve their local biodiversity.

4.1 Educational implications

Improving the educational outlook for biodiversity and conservation learning is the goal of Environmental Education. Findings of this study can be beneficial for biology textbook authors and science instructors to compare learning materials (sub-sections) taught in their

own country with the other countries. The result of the amount of native and non-native biological diversity species presented in each textbook could have implications for students to learn more about the richness of local biodiversity in their own country and non-native species that originally came from other countries.

4.2 Limitation

Since this study only selected few textbooks that we considered as popular biological textbooks in each country as research sample, these findings cannot be used to generalise the biodiversity contents presented in Korea, Indonesia, and the USA. Therefore, for further study I may add more research samples from these three countries in order to get more reliable data findings. Even, in the next study, I intend to pick biological textbook from other countries with different biodiversity resources, such as Finland and Japan.

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국문 초록

한국, 인도네시아, 미국 과학 교과서의 생물 다양성 관련 내용 비교

한국, 인도네시아, 미국의 중등 학교 학생들을위한 대표적인 생물학 교과서를 비교하여 각 국가의 생물 다양성 관련 내용의 차이점을 설명했습니다. 비교를 위해 전문 기술 서적이 참조 서적으로 추가되었습니다. 한국, 인도네시아 및 미국의 교과서에는 생물 다양성 내용의 주요 하위 섹션이 있습니다. 그러나 인도네시아와 미국의 생물학적 교과서에는 한국어 교과서와 다른 특별한 추가 하위 섹션이 있습니다. 그러나 이러한 생물학적 교과서 중 어느 것도 참고 문헌과 표준으로 완전히 유사한 설명을 제공하지 않았습니다. 각 국가에서 생물 다양성의 주요 주제를 설명하는 데는 몇 가지 차이점이 있었으므로, 교과 과정 컴파일러는 향후 생물 다양성 관련 내용을보다 잘 제시 할 수 있도록 적응 된 것이 좋습니다. 또한, 한국의 생물학 교과서 작성자는 특히 보존 하위 섹션에서 생물 다양성 내용에 더 많은 생물학적 다양성 사례를 추가 할 것을 제안합니다. 이를 통해 학생들은 생물학적 교과서를 통해 자국의 생물 다양성 풍부 성을 배우고 더 많이 알 수 있기를 바랍니다.

키워드 : 생물 다양성; 생물학 교과서; 보존; 과정; 천연 종; 비 천연 종

Acknowledgement

First of all, I would say I am so proud to be part of plant and wetland ecology lab and under supervised by 김재근 교수님. My highest gratitude to my professor, thank you very much for your guidance, advice, and assistance. Thank you for accepting me as your student in this 2 years. I was really motivated to publish journals and I'd like to do science research next time. Professor, someday I will invite you to be a keynote speaker in conference that I will held. I hope I can make it real. My highest gratitude also goes to 김영수 교수님, 전상학 교수님, 이전규 교수님 as lecturer in biology education department, and 김희백 교수님 as a dean of Science Education Faculty. Thank you for the correction and suggestion for the improvement of my thesis.

Secondly, my gratitude to my lab mates in plant and wetland ecology lab. 이보 언니 is the first buddy that I talked to when I came to lab for the first time. Thank you for taught me Korean, eat 컵밥 together, listened to my difficulties, gave me suggestions, and cheer me up. Thank you eonni, I always pray for your healthy and your baby girl. 락연 언니, thank you for helping me solved my administrative issues. I hope you have a great time with your family in France ahead. 호님, thank you for your kindness dropped me off to bus station when we finished lab semester-end dinner in hoam faculty house. 남보 언니, thank you for helping me corrected the graph of my paper, informed me about scholarship, and gave me snacks to cheer me up in the day of my final defense presentation. You are such a diligent and smart student. 가연, thank you for helping me edited my paper and helped me to solved my problem in NH bank when I first came here, and thank you for lending me your shoes when we were in Jeju for conference ㅎㅎ. 혜경, thank you for guiding me submit conference incentive application to BK, edited my conference presentation slides, and gave me other

favors. I think you are the most diligent student in our lab kkk. I hope you and 가연 can achieve your passion to pursue your doctoral degree in the US. You guys are just so great students. 현준, I think you are so smart, thank you for correcting my Korean script, and informed me any important activities and gatherings. 유성, I hope you have enjoyable moments in the rest of your study here. Thank you for always answered my questions if I asked you about Korean grammar ㅎㅎ. I also thank to 민지 and 유연, for the kindness being my friends, although we are in different lab, we used to have lunch, dinner and go home together. To 최섭 오빠, thank you very much for your generous helped me in statistics class, invited me to educational events, and helped me checked my Korean class assignments and my final defense presentations slides.

Thirdly, thanks to LPDP (Indonesia endowment fund for education) that facilitated my study abroad by providing financial support for my master degree. I also thank to Sinyang, Gwansa, SNU Global, and BK for providing additional financial aid for having free Korean class and participating in international conference.

Lastly, I would say I am very thankful and grateful to the God because already gave me chance to have this precious experience. Even though it was challenging to study overseas yet I am so glad that I finished my study in SNU, lived in Korea for 2 years and met the inspired professors and friends in SNU. I will never forget the moment I spent with all the people that I met. For all the kindness and togetherness, thank you so much. I apologize if I have mistaken either in my words or in my behavior. I really did not intend to do it.

Finally, I am looking forward to meet all of you in the other occasions. May we always be healthy and I'd love to see you again

someday in Korea, Indonesia, or somewhere around the world. Keep in touch^^ 감사합니다~