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RESEARCH ARTICLE

Adequacy of Inquiry Activities in Life Science II Based on the 2015 Revised Science Curriculum

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2015 개정 과학과 교육과정 생명과학 II에 제시된 탐구 활동의 적절성

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Abstract

In education, a curriculum is the blueprint that suggests educational directions and serves as a basis for formal schooling. The revision of the curriculum is made upon the demands of both the nation and the society. The science curriculum emphasizes inquiry, the most essential element of science education. The 2015 revised science curriculum presents inquiry activities as one of the methods that place high importance on inquiry. However, no analysis has been conducted to examine whether the inquiry activities in the curriculum are adequately implemented in each unit. In this regard, this study sought to analyze the adequacy of inquiry activities in Life Science II based on the 2015 Revised Science Curriculum. To this end, a connection network between the inquiry activity in the textbook and the concept presented in the main text was analyzed by using semantic network analysis. The results showed that there are units in which inquiry activities in the curriculum are not adequate, and no inquiry activities are undertaken in areas that pose difficulties in the processes of observation and experimentation. Therefore, based on the findings of this study, it is expected that the inquiry activities of the curriculum will be presented in the following areas, such as life science inquiry methods, cellular respiration, and regulation of gene expression, to which inquiry activities were not given.

Key words: Inquiry activities, life science II, 2015 revised science curriculum, semantic network analysis, connection network

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Introduction

The national curriculum in the Republic of Korea is a blueprint that presents the directions of elementary and secondary education and becomes the basis for school education practice. In the Republic of Korea, the curriculum is established at the national level and has been revised upon the demands of both the nation and the society. The importance of inquiry, a scientific method, has been highlighted in both national and international science education reforms, including curriculum revision (Bybee et al., 2008).

Inquiry in science education refers to activities that help students develop their understanding of scientific research methods and scientific ideas on natural phenomena (NRC, 2000). The act of inquiry is the most essential element in science education, and many researchers argue that science education should be focused on the said activity. Even in the Republic of Korea, science education is designed to encourage students to learn science concepts through inquiry activities (Kim et al., 2017). Accordingly, the 2015 Revised Science Curriculum presents activities that should be done in the relevant unit to disseminate science content as inquiry activities, which include specific types of tasks (Park, 2017). Moreover, the science curriculum allows various types of inquiry-centered learning, together with the understanding of basic concepts, through which it helps students cultivate core competencies in science, such as scientific thinking and scientific inquiry skills (MOE, 2015).

Meanwhile, textbooks are the basic materials used in implementing the national-level curriculum and serve as key educational materials to determine the content and method of classroom discussion (Angus, 2004). Furthermore, textbooks have a huge impact on students' learning because most science teachers plan and organize learning activities based on them (Weinburgh, 2003). With the growing importance of scientific inquiry, research on inquiry activities in science textbooks has been continuously carried out. Most of the studies dealt with the changes (Park, 2017) and types (Kim et al., 2017; Kim et al., 2021) of inquiry activities in textbooks based on the curriculum. As such, analysis has mainly been focused on the external aspects of inquiry activities presented in science textbooks, and the adequacy of inquiry activities in the curriculum has not yet been analyzed.

Life Science Ⅱ is one of the career-related subjects in high school and is thus designed for students who plan to pursue a career or entrance into a school of higher grade as an advanced course in Life Science Ⅰ (MOE, 2015). Life Science Ⅱ is a subject that is intended to provide academic curiosity and interest based on the understanding of the core concepts of life science and to cultivate the basic knowledge attainment to go on to the next stage of life science education. Previous studies on Life Science Ⅱ dealt only with guidance plans for each unit (Nam & Cho, 2017), connection with Life Science Ⅰ (Jeong & Chang, 2020), comparison of writing activities (Shim et al., 2022), and analysis of inquiry activities (Jeong & Chang, 2019). However, no research has been done on the adequacy of inquiry activities in the curriculum. Therefore, this study attempted to confirm the adequacy of inquiry activities presented in the 2015 Revised Science Curriculum for Life Science Ⅱ.

The semantic network analysis method was used to analyze the adequacy of inquiry activities in Life Science Ⅱ based on the 2015 revised science curriculum. The semantic network analysis method serves to examine the structural relationship between concepts in the text, and it was used in the research on the curricular connection (Park et al., 2018), the connection network between the curriculum and textbooks (Kim et al., 2018; Kwon et al., 2018), the connection

network among the curriculum, textbooks, instruction, and evaluation (Kim et al., 2019; Kim et al., 2022), and the consistency of concepts used in the inquiry process (Jeong et al., 2019). In this regard, this study sought to analyze the adequacy of inquiry activities presented in Life Science Ⅱ, based on the 2015 Revised Science Curriculum, via a connection network between the inquiry activity in the textbook and the concept described in the main text. The findings of this study are expected to be used as basic data to establish inquiry activities that represent each unit in the 2022 Revised Curriculum, and to develop new inquiry activities.

Materials and Methods

Research Subjects

The inquiry activities and texts in Life Science Ⅱ textbooks in relation to the inquiry activities presented in Life Science Ⅱ of the 2015 Revised Science Curriculum were selected as research subjects for this study. The three most popular textbooks used in high schools were selected from among authorized and approved Life Science Ⅱ textbooks. The publishers of the selected textbooks include VISANG (Shim et al., 2017), Mirae-N (Oh et al., 2017), and JIHAKSA (Jeon et al., 2017).

To analyze the adequacy of inquiry activities in the curriculum, only the inquiry activities in Life Science Ⅱ of the 2015 Revised Science Curriculum were selected from among inquiry activities in the textbooks. The inquiry activities presented in the 2015 Revised Science Curriculum are summarized in Table 1. The analyzed inquiry activities included introductions to inquiry, data, process, results, and summary. Among the adopted textbooks, the class-related contents were selected, and the inquiry activities and concepts presented in the main texts corresponding to the selected contents were analyzed. While contents in the form of pictures or tables, opening texts at the beginning and the end of the unit, and science in history were excluded.

Research Methods

First, among the inquiry activities in the 2015 Revised Science Curriculum, those included in the textbook and the text given in the textbook were transcribed. Based on the units of a sentence, a single file was created, and the transcribed content was then pre-processed by using the NetMiner 4.0 program. Pre-processing involves deleting the predicate and postpositions with only the concept in the sentence left, through which unconjugated adjectives, suffixes, and conjunctions that do not carry meaning in themselves were removed (Lim & Kim, 2015). Extracted concepts were based on a noun form, and synonyms (e.g., ABO type and ABO controlled to ABO) and word spacing between words underwent a control process (Park et al., 2021).

Next, three life science teachers were asked to select concepts that have no meaning in terms of life science among the extracted concepts. Then, concepts that two of the three teachers judged to be meaningless were excluded before selecting the final concept. The three life science teachers are all in-service teachers with doctorate degrees and have more than ten years of educational experience. The number of concepts selected through the above-mentioned process is shown in Table 2.

Table 1. Inquiry activities for each unit in life science II based on the 2015 revised science curriculum

Unit	Inquiry Activities
History of life science	· Investigate and make a presentation on the discoveries of life science that have contributed to human welfare
Characteristics of cells	· Test the movement of substances through membranes
	· Investigate and discuss the utilization of liposomes
	· Test the action of enzymes
	· Examine the uses of enzymes in daily life
Cellular respiration and photosynthesis	· Investigate the history of science in relation to photosynthesis
	· Separate pigments from leaves
	· Experiment with fermentation
Gene expression and regulation	· Simulate semi-conservative replication with a DNA model
	· Extract and observe DNA
	· Simulate the information flow of the central dogma
	· Investigate the latest research regarding the regulation of gene expression and development
Evolution and diversity of living organisms	· Conduct a simulation in relation to the Hardy-Weinberg law
	· Investigate changes in the gene pool
	· Compare the differences between five and six kingdom systems, and discuss their major differences
	· Build phylogenetic trees based on specific traits
	· Classify surrounding plants and animals at the phylum level, and identify phylogenetic relationships
	· Investigate and discuss the cases of ring species
Biotechnology and human life	· Conduct a simulation on genetic recombination
	· Observe bacterial colonies
	· Investigate and make a presentation on the impact of LMOs in our lives
	· Make decisions on bioethical issues

Table 2. Number of selected concepts per unit

Unit	Number of Concepts
History of life science	182
Characteristics of cells	206
Cellular respiration and photosynthesis	100
Gene expression and regulation	116
Evolution and diversity of living organisms	212
Biotechnology and human life	89

Lastly, the selected concepts were analyzed by using the NetMiner 4.0 program. The analysis was done for each unit and visualization was made with a two-mode network based on the concept that appeared simultaneously between the inquiry activity in the curriculum and the text used in the textbook. The two-mode network is a method that is suitable to analyze the connectivity of different groups (Lim & Kim, 2015).

Results and Discussions

'History of Life Science' Unit

The inquiry activities presented in the 'History of life science' unit of the 2015 Revised Science Curriculum include the investigation and the presentation of the discoveries in life science that have contributed to human welfare.

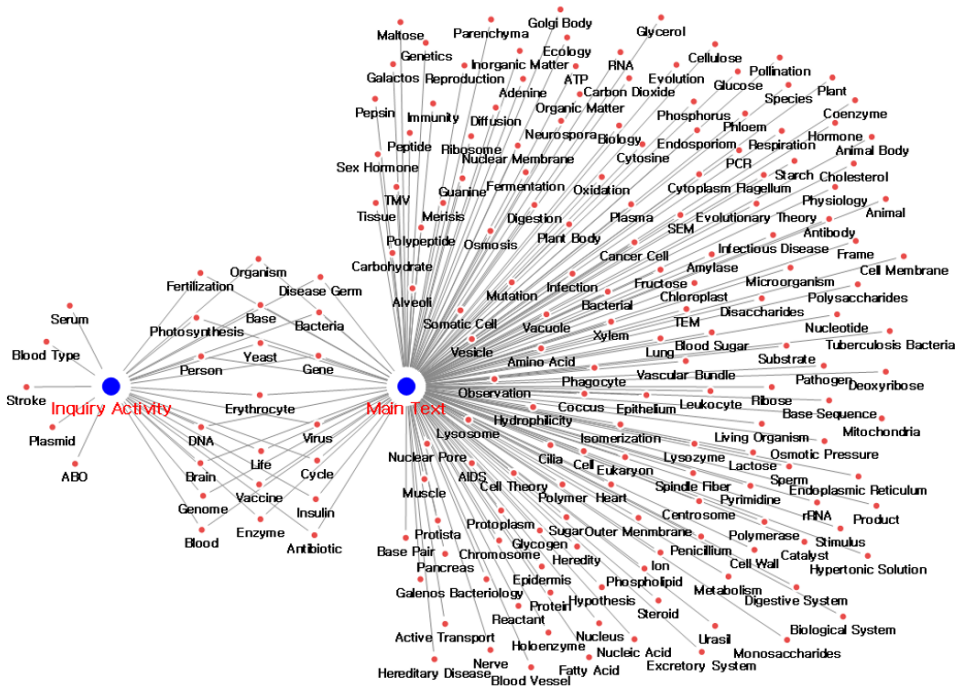

Fig. 1. The connection network between the concepts presented in the inquiry activities and the main text of the 'History of life science' unit

In relation to the inquiry activities included in the 2015 Revised Science Curriculum, the connection network between presented concepts in the inquiry activities and the main text in the 'History of life science' unit of the textbook is shown in Fig. 1. There are 21 concepts connected between the inquiry activities and the main text, including 'fertilization', 'brain', 'life', 'insulin', 'virus', 'antibiotic', 'genome', 'base', 'blood', 'enzyme', and 'DNA'. Meanwhile, the concepts that appear only in the inquiry activities include 'ABO', 'plasmid', 'serum', and 'blood type', whereas those that appear only in the main text consist of 156 concepts, including 'mutation', 'TMV', 'phagocyte', 'TEM', and 'plasma'.

The achievement criteria of the 'History of life science' unit require students to learn about the history and the advances in modern life science for them to be interested in the advances in modern life science as it contributes to the sustainability of human life. Moreover, students are required to learn creative and innovative experimental techniques as well as the ideas of life scientists that have contributed to the development of life science (MOE, 2015). However, the inquiry activities in the curriculum pertain to the contribution of the development of life science to human life, and there are no inquiry activities related to the research methods involved in the study of life science.

Even in the connection network, the concept of connecting between the inquiry activities and the main text appeared in the advances in modern life science. On the other hand, the concepts presented only in the inquiry activities include those that appear in the advances in modern life science, while the concepts in the main text are mostly related to the history of life science. In the main text of the textbook, only observation and hypothesis concepts were given as concepts related to the research methods of life science. Observation is the most basic element of inquiry ability (AAAS, 1967) and plays an important role not only in life science inquiry activities but also in life science learning in general (Gott & Welford, 1987; Klahr et al., 1993; Malcolm, 1987). Observation is very important in life science research, but there are many other important inquiry elements and methods. Therefore, inquiry activities on the research methods of life science and the contents of the research methods should be also described in the main text of the textbook.

'Characteristics of Cells' Unit

The 'Characteristics of cells' unit of the 2015 Revised Science Curriculum presents a total of four inquiry activities: experimenting with the movement of substances through membranes, investigating the utilization of liposomes, testing the action of enzymes, and examining the uses of enzymes in daily life.

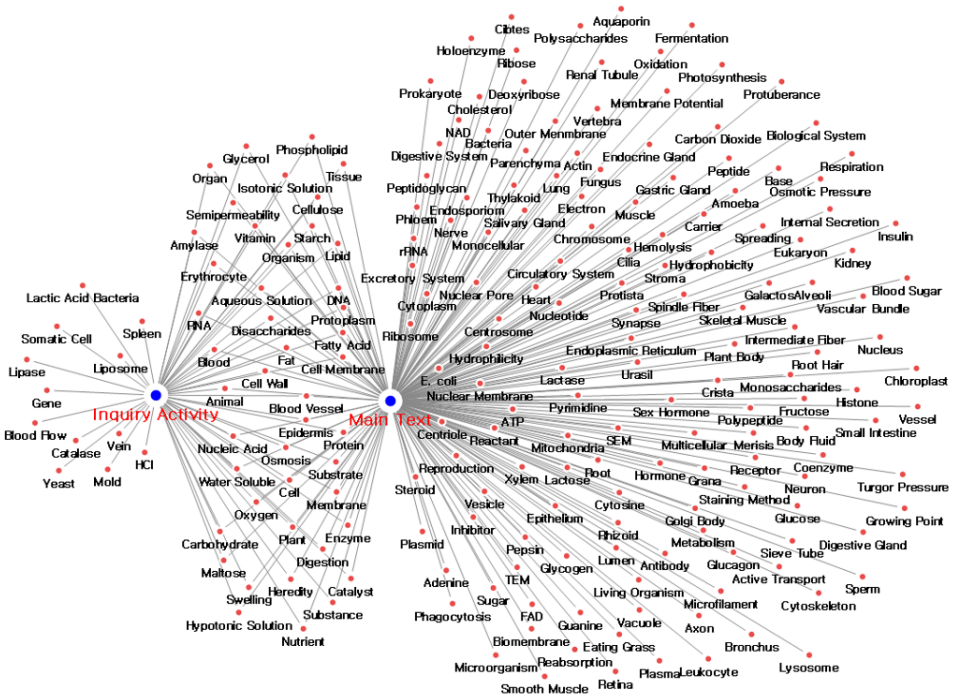

Fig. 2. The connection network between the concepts presented in the inquiry activities and the main text of the 'Characteristics of cells' unit

Regarding the inquiry activities in the 2015 Revised Science Curriculum, the connection network between presented concepts in the inquiry activities and the main text in the 'Characteristics of cells' unit of the textbook is shown in Table 2. There are 46 concepts connected between the inquiry activities and the main text in the textbook, including 'hypotonic solution', 'blood', 'blood vessel', 'plant', 'phospholipid', 'cell wall', 'protoplasm', 'starch', 'disaccharides', 'protein',

'amylase', 'catalyst', and 'enzyme'. In the meantime, the concepts that appear only in the inquiry activities include 'gene', 'yeast', 'vein', 'lipase', 'somatic cell', 'lipase', and 'liposome', whereas there are 149 concepts that appear only in the main text, including 'glucose', 'cell', 'ribosome', nuclear pore', 'microfilament', and 'E. coli'. At this time, concepts that connect between the inquiry activities and the main text in the textbook correspond mainly to the main materials that make up living organisms, such as 'nucleic acid', 'DNA', 'heredity', 'RNA', 'lipid', and 'protein'.

The 'Characteristics of cells' unit is designed for students who want to learn about cells, which are the basic units of life, and deal with the organic composition of living organisms. They are the main materials that make up living things, prokaryotic and eukaryotic cells, the structures and functions of cell organelles, the entry and exit of substances through the cell membrane, and the action of enzymes (MOE, 2015). However, examples of inquiry activities, such as the organic composition of living organisms and the difference between prokaryotic and eukaryotic cells, are not provided in the curriculum. Still, they are included in the textbook. Furthermore, activities related to real-life issues, such as the investigation of the uses of enzymes in daily life, are presented in the inquiry activity, though they are not discussed in the main text of the textbook.

'Cellular Respiration and Photosynthesis' Unit

The 'Cellular respiration and photosynthesis' unit of the 2015 Revised Science Curriculum presents a total of three activities: investigation of the history of science related to photosynthesis, separation of pigments from leaves, and an experiment with fermentation.

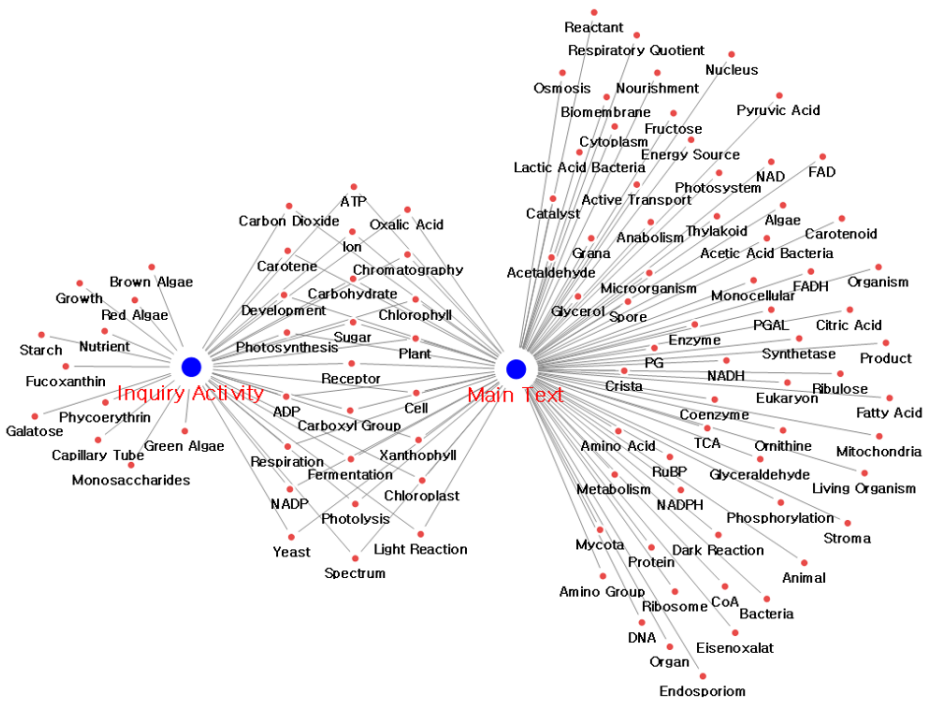

Fig. 3. The connection network between the concepts presented in the inquiry activities and the main text of the 'Cellular respiration and photosynthesis' unit

Regarding the inquiry activities in the 2015 Revised Science Curriculum, the connection network between the inquiry activities presented in the 'Cellular respiration and photosynthesis' unit of Life Science Ⅱ textbook and the main text of the textbook is shown in Fig. 3. There are 25 concepts that connect the inquiry activities and the main text of the textbook, including 'carotene', 'photosynthesis', 'ADP', 'cell', and 'respiration'. Meanwhile, there are 64 concepts that appear only in the main text, including 'energy source', 'citric acid', 'fructose', and 'mitochondria'. Whereas there are 11 concepts that appear only in the inquiry activities, including 'red algae', 'phycoerythrin', 'fucoxanthin', 'capillary tube', 'green algae', 'brown algae', etc.

The 'Cellular respiration and photosynthesis' unit is intended for students who want to understand the electron microscopic structure and the function of mitochondria and chloroplasts, identify the relationship between cellular respiration and photosynthesis, and learn the difference between aerobic respiration and fermentation (MOE, 2015). As such, although this unit should include both cellular respiration and photosynthesis, most of the inquiry activities presented in the curriculum were related to photosynthesis.

Similarly, in the connection network analysis results, the concepts that connect the inquiry activities and the main text were mainly related to photosynthesis and fermentation, while the concepts in the inquiry activities were the only concepts that appeared in the process of such activities. Moreover, the concepts presented only in the main text were also the concepts related to photosynthesis and fermentation, and those related to cellular respiration were additionally presented. As such, the inquiry activities related to cellular respiration were the ones that cannot be directly performed. They were described as data interpretation activities on the oxidation of pyruvic acid, TCA, and ATP synthesis in the inner mitochondrial membrane. Therefore, even in the curriculum, inquiry activities related to cellular respiration must be additionally described to present it at the same level as photosynthesis.

'Gene Expression and Regulation' Unit

The 'Gene expression and regulation' unit of the 2015 Revised Science Curriculum presents a total of four inquiry activities: simulating semi-conservative replication with a DNA model, DNA extraction, simulating the information flow of the central dogma, and examining data related to the regulation of gene expression and development.

Regarding the inquiry activities in the 2015 Revised Science Curriculum, the connection network between presented concepts in the inquiry activities and the main text in the 'Gene expression and regulation' unit of the textbook is shown in Fig. 4. There are 40 concepts that connect the inquiry activities and the main text of the textbook, including 'cell', 'cell membrane', 'fertilization', 'gene', 'base', and 'nucleus'. In the meantime, there are 60 concepts that appear only in the main text, including 'nuclear pore', 'operon', 'genome', and 'polymerase', whereas there are 17 concepts that appear only in the inquiry activities, such as 'amino group', 'plant', 'pistil', etc.

The 'Gene expression and regulation' unit is designed for students who want to understand the expression and regulation of life information at the molecular level, and learn it in connection with the DNA characteristics and replication process, and initial development process (MOE, 2015). However, in the curriculum, three out of four inquiry activities are focused on activities related to gene expression. Moreover, even in the connection network, the concepts that connect the inquiry activities and the main text are largely composed of gene expression.

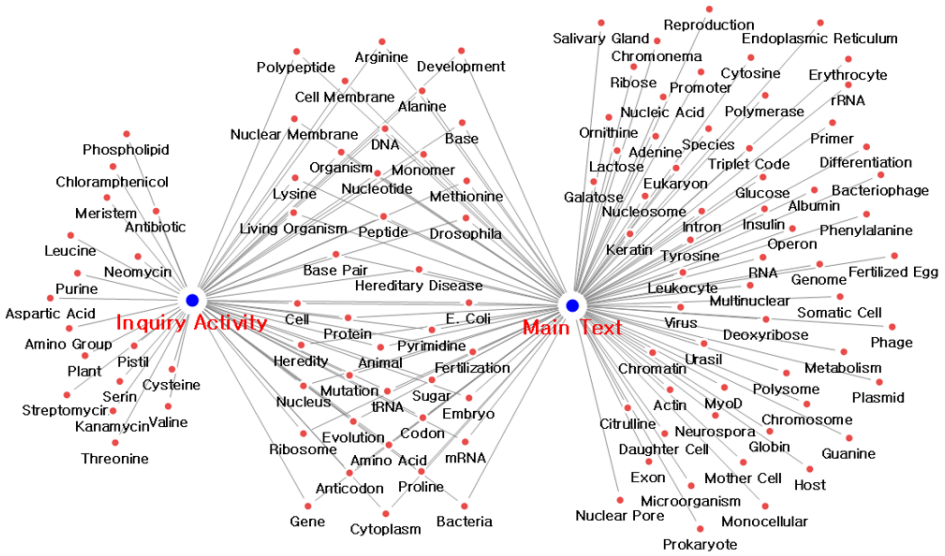

Fig. 4. The connection network between the concepts presented in the inquiry activities and the main text of the 'Gene expression and regulation' unit

Furthermore, inquiry activities related to regulation of gene expression are presented only in the curriculum. There are no additional explanations regarding the inquiry activities or concept descriptions in the main text of the textbook. These results suggest that there is still a lack of connection between the inquiry activities presented in the 'Gene expression and regulation' unit and the concepts in the main text.

The 'Gene expression and regulation' unit is intended for students who want to understand the expression and regulation of life information at the molecular level, and learn it in connection with the DNA characteristics and replication process, and initial development process (MOE, 2015). However, in the curriculum, inquiry activities are focused only on the parts related to gene expression, and data on gene transcription control is included in the textbook only in the form of data interpretation.

'Evolution and Diversity of Living Organisms' Unit

The 'Evolution and diversity of living organisms' unit of the 2015 Revised Science Curriculum presents a total of six inquiry activities: conducting a simulation related to the Hardy-Weinberg law, investigating changes in the gene pool, comparing the differences between five and six kingdom systems, building phylogenetic trees, classifying plants and animals and identifying their phylogenetic relationships, and investigating the cases of ring species.

Regarding the inquiry activities in the 2015 Revised Science Curriculum, the connection network between presented concepts in the inquiry activities and the main text in the 'Evolution and diversity of living organisms' unit of the textbook is shown in Fig. 5. There are 67 concepts that connect the inquiry activities in the curriculum and the main text of the textbook, including 'evolution', 'bacteria', 'Carl Linnaeus', 'phylum', 'mutation', 'Monera', 'predator', 'reproduction', and 'gene pool'. Meanwhile, there are 11 concepts presented only in the inquiry activities, such as 'subphylum', 'histone', and 'biosystem', while there are 133 concepts in the textbook, such as 'anatomy', 'spiral', 'crustaceans', and 'ecosystem'.

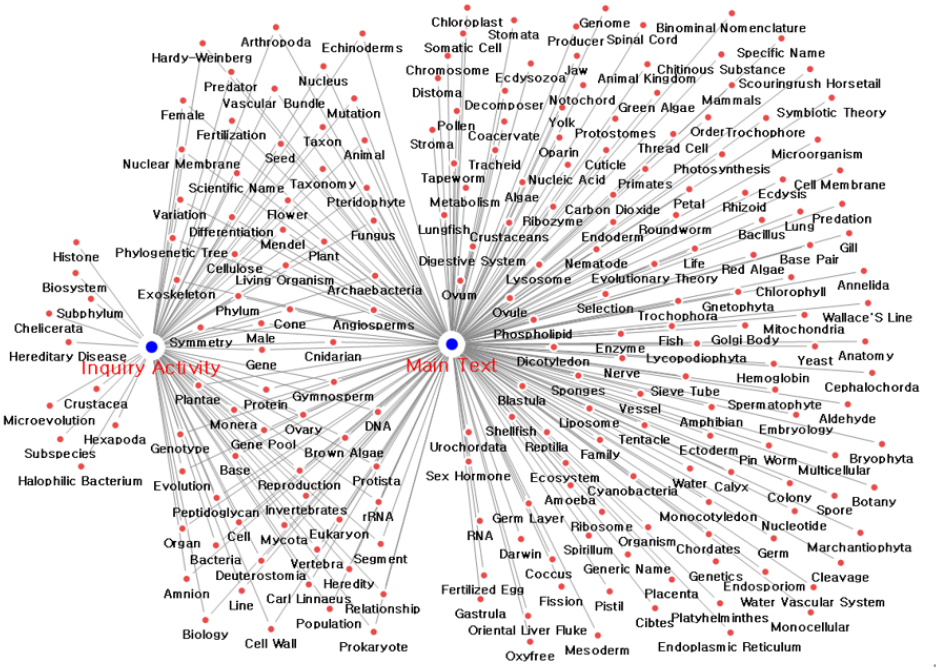

Fig. 5. The connection network between the concepts presented in the inquiry activities and the main text of the 'Evolution and diversity of living organisms' unit

The 'Evolution and diversity of living organisms' unit is designed for students who want to understand the origin and evolution process of living organisms, and to recognize the importance of biodiversity. In this regard, this unit deals with the general principles of biological evolution and mechanisms of speciation, and helps in understanding the latest classification system based on phylogenetic relationships according to the biological phylogenetic tree (MOE, 2015). However, the inquiry activities presented in the curriculum are focused only on the evolutionary principle and the differentiation mechanism without any inquiry activities related to the birth and evolution of protists.

'Biotechnology and Human Life' Unit

The 'Biotechnology and human life' unit of the 2015 Revised Science Curriculum presents a total of four inquiry activities: genetic recombination, observation of bacterial colonies, investigation of the impact of LMOs in our lives, and decision-making on bioethical issues.

Regarding the inquiry activities in the 2015 Revised Science Curriculum, the connection network between presented concepts in the inquiry activities and the main text in the 'Biotechnology and human life' unit of the textbook is shown in Fig. 6. There are 38 concepts that connect the inquiry activities in the curriculum and the main text, including 'cell wall', 'endemic species', 'heredity', 'colony', and 'development'. In the meantime, there are 33 concepts that appear only in the main text, such as 'antigen', 'immunity', 'fertilized egg', 'antibody', and 'pathogen', whereas there are 18 concepts that appear only in the inquiry activities, such as 'ovulation', 'allergy', and 'ecosystem'. Therefore, it was found that the 'Biotechnology and human life' unit has relatively more concepts that connect the inquiry activities and the main text when compared to other units.

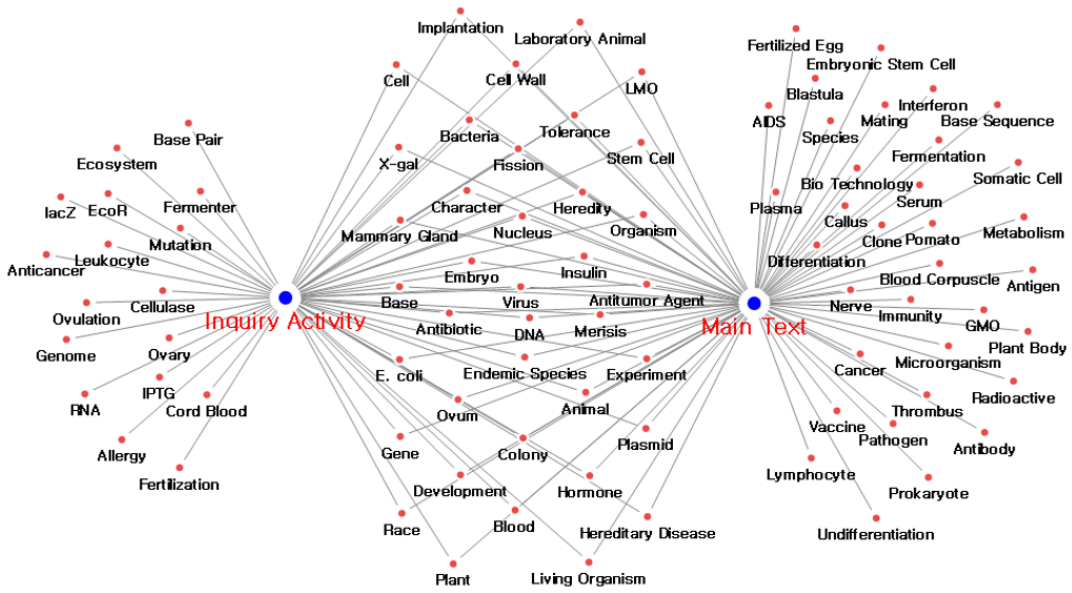

Fig. 6. The connection network between the concepts presented in the inquiry activities and the main text of the 'Biotechnology and human life' unit

The results of the connection network showed that the concepts that connect the inquiry activities and the main text were mainly related to genetic recombination technology. The concepts presented only in the inquiry activities were also additional concepts related to genetic recombination, while those presented only in the main text were mostly related to biotechnology.

Discussion

Up to now, the connection network that connects the inquiry activities in Life Science Ⅱ of the 2015 Revised Science Curriculum and the main text of the textbook has been examined for each unit. In this study, it was found that many concepts appear only in inquiry activities. In the research of Oh et al. (2022), which analyzed the adequacy of inquiry activities presented in Life Science Curriculum of the middle school, most of the concepts presented in the inquiry activities were related to the concepts in the main text. However, in Life Science Ⅱ, five to 18 concepts were described in the inquiry activity, but they were not explained in the main text.

Likewise, if the concepts are not described in the main text, and they are described only in the inquiry activity, it is highly likely that understanding of a specific concept is lacking when the class is conducted with no inquiry activities. Furthermore, this is not in line with the goals of science education to help students understand key concepts through inquiry activities (Kim et al., 2017; Kim et al., 2022; Oh et al., 2022). Therefore, a more careful approach to selecting concepts is needed when describing the inquiry activities of the Life Science Ⅱ Curriculum.

And when inquiry activities are not presented in the curriculum, activities such as data interpretation and application are included in the textbook as inquiry activities in most of the units, although there are no inquiry activities presented in

the curriculum. However, in some cases, inquiry activities were not included in the textbook. In the 'Cellular respiration and photosynthesis' unit, although inquiry activities related to cellular respiration were not presented in the curriculum, activities such as data interpretation or application were included in the textbook as inquiry activities. Through this, efforts were made to optimize the ratio of inquiry activities, which could be biased towards photosynthesis, to be equal to cellular respiration when describing textbooks. Still, in the case of the 'History of life science' unit, inquiry activities for research methods used in life science education were not presented both in the curriculum and in the textbook. Therefore, in the 2022 Revised Science Curriculum and in the textbook development process, it is expected that examples of research methods such as hypothesis deduction method, induction method, deduction method, and abduction method, which are mainly used as life science research methods, will be added. For example, it is hoped that additional supplementation will be made in specific ways, such as doing or using the science history.

Moreover, there were more concepts that do not connect the inquiry activity to the main text, that is, the concepts presented only in the inquiry activity or the main text, when compared to that of middle school science (Kim, 2020). Specifically, there were 156 concepts presented in the main text with no connection with inquiry activities, the largest in the 'History of life science' unit, which is the first unit of Life Science Ⅱ. As such, many concepts are presented to students without related inquiry activities from the first unit of the subject. Therefore, an overall improvement is required to connect the inquiry activity and the main text.

Meanwhile, the difference in the number of concepts connecting the inquiry activity and the main text and the number of concepts presented in the main text of the textbook varied, depending on the unit. Therefore, additional data on the curriculum and textbook description methods must be obtained via a comparison between the differences in the students' learning and understanding for each unit with such differences.

Lastly, five out of 22 activities presented in the curriculum are inquiry activities related to social issues or realities of life, which include investigation of uses of enzymes in daily life, investigation of the latest data on gene expression and development, case study of ring species, impact of LMOs, and decision-making for bioethical issues. In the main text of the textbook, few explanations were given in relation to these inquiry activities. In the case of some inquiry activities, there was no explanation in the main text although inquiry activities were present.

It is important for students to engage in inquiry activities with scientific ideas, concepts, and principles in order to meaningfully learn scientific knowledge (Millar, 1998; Osborne, 1998; Wellington, 1998). Students can learn scientific knowledge more meaningfully by experiencing social issues related to real life related to science. Therefore, it is necessary not only to increase the number of inquiry activities related to real life or social issues, but also to make the text explanation of related contents more faithful as the realities of life are emphasized in learning life science.

Conclusions and Suggestions

This study analyses the adequacy of inquiry activities presented in each unit of Life Science Ⅱ based on the 2015 Revised Science Curriculum. To this end, it analyzed how concepts related to inquiry activities in the 2015 Revised Science Curriculum are connected to the inquiry activities of the Life Science Ⅱ textbook and presented in the main text.

The conclusions of this study are following.

First, there are units in which inquiry activities in the curriculum are not appropriate. Regarding the degree of connection between the inquiry activities of the textbook and the concepts in the main text, there is no connection between the inquiry activity and the main text, and many concepts are described only in the text, or only in the inquiry activity. Moreover, there are cases where inquiry activities presented in the curriculum cover only a part of the unit. For example, in the 'History of life science' unit, one inquiry activity covered the development process of life science, but failed to present inquiry activities related to life science research methods. Therefore, there is a need to supplement inquiry activities related to life science research methods with various forms such as doing and reading materials related to science history.

Second, in the Curriculum of Life Science Ⅱ, inquiry activities are not implemented in areas that pose difficulties in the processes of observation and experimentation. In the 'Cellular respiration and photosynthesis' unit, inquiry activities related to cellular respiration are not given, and in the 'Gene expression and regulation' unit, inquiry activities related to gene regulation are not presented in the curriculum. Therefore, complementary measures must address this problem. Therefore, it is necessary to explicitly present specific inquiry activities such as the composition of living things, the structure and function of cells, cellular respiration, and inquiry activities related to the origin of life in the 2022 Revised Science Curriculum.

Third, statements on inquiry activities related to social issues in the textbook are inadequate. Inquiry activities related to the realities of life or social issues are presented only in the inquiry activity, and are not explained in the main text of the textbook. Therefore, complementary measures must address this problem.

Through this study, inquiry activities on areas such as life science inquiry methods, cellular respiration, and regulation of gene expression are included in the curriculum, and detailed contents related to the realities of life or social issues are described in the textbook will help promote students' understanding of life science.

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