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RESEARCH ARTICLE

Development of Integrated Curriculum for Basic Dental Hygiene Based on Competencies

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Background: To train dental hygienists to utilize knowledge in practice, an integrated curriculum based on the competencies of dental hygienists is expanding; however, in the field of basic dental hygiene the curriculum is still fragmented and based on segmented knowledge. This study developed an integrated curriculum based on the competencies of dental hygienists in Anatomy, Histology & Embryology, Physiology, which are subjects for basic dental hygiene that have high linkage and overlap.

Methods: After selecting the learning objectives for the integrated curriculum from those of Anatomy, Histology & Embryology, Physiology, the duties of the dental hygienist in relation to the learning objectives were analyzed. Learning objectives were combined with the duties of a dental hygienist to derive competencies for an integrated curriculum. Referring to the syllabus and learning objectives for each subject, the weekly educational content, learning objectives, and credits of the integrated curriculum were derived. After conducting a Delphi survey to validate the competency and content of the derived integrated curriculum, an integrated curriculum was developed.

Results: By using the first and second Delphi surveys, four competencies were developed for dental hygienists that can be achieved through an integrated basic dental hygiene curriculum. In addition, an integrated curriculum including the courses Anatomy, Histology & Embryology, Physiology, Structure and Function of the Human Body/Head/Neck, and Structure and Function of the Oral Cavity was established.

Conclusion: This study presents a specific example for developing a competency-based integrated curriculum that can be used as a framework to derive a competency-based integrated curriculum among subjects that can be integrated according to the linkage of learning contents and the competencies that can be achieved.

Key Words: Basic subjects, Competency-based education, Curriculum, Dental hygiene, Integrated curriculum

Introduction

1. Background

As modern society enters the 4th Industrial Revolution and changes rapidly, there are many different ways to access knowledge, and cramming education that unilaterally transfers a large amount of knowledge is no longer relevant[1]. Adapting to a rapidly changing society beyond the acquisition of academic knowledge requires the acquisition of high-level and comprehensive skills, including communication, analytical thinking, problem solving, creative thinking, interpersonal, and self-management skills[2]. Competency refers to the comprehensive skills required to cope with the needs of society, and competency-based education is applied and emphasized in higher education[2]. In particular, in university education that trains professionals, competency-based education defines the essential roles of professionals, stipulates the competencies required to perform these roles in practice, organizes curriculum based on these defined competencies, and educates and assesses learners

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through educational methods necessary to achieve these competencies[3].

Dental hygienists are professionals who are responsible for improving the oral health of the public by providing oral health education, preventive dental treatment, dental care cooperation, and management support to local residents and people with dental diseases; thus competency-based education is required for training dental hygienists. Accordingly, to expand competency-based education in dental hygiene education, Bae et al.[1] defined the competencies of dental hygienists and proposed 8 core competencies and 52 specific competencies that dental hygienists should achieve by the time of graduation; Kim et al.[4] identified standard competencies for dental hygienists at the national level that can be applied in the educational field; and Choi et al.[5] introduced a competency evaluation system to analyze student levels of competency achieved by grade and semester.

In competency-based education, the process is organized around integrated and comprehensive problem-recognition and problem-solving skills[3]. Therefore, Park[3] has emphasized utilizing an integrated curriculum of competency-based dental education and suggested establishing competencies that dentists should possess and integrate this knowledge in relation to these competencies. The operation of an integrated curriculum based on the linkage of knowledge allows for an understanding of the totality of knowledge and can broaden the range of practice-focused thinking and strengthen problem-solving and work performance skills[6]. For this reason, to train healthcare professionals who can utilize and apply knowledge in practice, the operation of integrated subjects is expanding in Medicine, Dentistry, and Nursing, which focus on competency-based education[6,7].

Competency-based education in the current dental hygiene curriculum is well established and expanding; however, the integration of subjects has only been implemented in a few dental hygiene fields. Although research is being conducted to integrate courses in clinical dental hygiene and clinical dental hygiene based on competencies and integrated subjects within the field of clinical dental hygiene are being implemented in actual curricula, subjects in the field of basic dental hygiene are still offered subject-centered courses with fragmented knowledge[1,8]. In dental hygiene education, the basic dental hygiene field is the most fundamental of the specialized knowledge to be dealt with in dental hygiene and provide the foundation for solving clinical problems[9]. According to study by Lee et al.[10], when analyzing the overlapping learning content between courses in the field of basic dental hygiene, overlapping content was found in all courses, and the most overlapping content occurred in the following order: Oral Histology and Oral Physiology, Oral Histology and Tooth Morphology, and Oral Physiology and Oral Anatomy. Despite this overlap in content, the subject-centered curriculum in the current basic dental hygiene makes it difficult to think integrally and limits the development of problem-solving skills[10].

The establishment and strengthening of a competency-based curriculum in dental hygiene education requires the introduction of a competency-based integrated curriculum in the field of basic dental hygiene; subjects with linkages and overlaps in knowledge should be prioritized for integration. Among the basic dental hygiene subjects, there is a link between the courses Anatomy, Histology & Embryology, and Physiology because Anatomy is the study of the normal structure of the human body, head and neck, and oral cavity; Histology is the study of the microscopic state of normal structures as part of Anatomy; and Physiology is the study of the normal functioning of the various tissues that make up the human body, head and neck, and oral cavity[11].

2. Objectives

Therefore, to enhance competency-based dental hygiene education, this study developed a competency-based integrated curriculum including Anatomy, Histology & Embryology, and Physiology, which are courses with high knowledge linkage and overlap in the field of basic dental hygiene.

Materials and Methods

1. Derivation of competencies for integrated subjects

Referring to the Dental Hygiene Department Learning Objectives published by the Korea Dental Hygienists Association, the learning objectives of the courses Anatomy, Histology & Embryology, and Physiology were listed, and overlapping content was arranged. The arranged learning

objectives were then selected as the learning objectives for the integrated subjects[12].

After selecting the learning objectives for the integrated subjects, the duties of dental hygienists that could be performed using the learning objectives were analyzed based on the research of Park et al.[13]. Based on the study by Bae et al.[1], the competencies that dental hygienists should achieve from the learning objectives of integrated subjects were identified. The competencies of the integrated subjects were derived by referring to the learning objectives of the integrated curriculum, dental hygienist duties that can be performed through the learning objectives, and dental hygienist competencies that should be achieved through the learning objectives.

2. Derivation of competency-based integrated curriculum

The learning objectives of the integrated curriculum were rearranged based on their correlation with the derived competencies. At this point, competencies with overlap in the listed learning objectives were determined to be covered in the same curriculum and categorized. Two curriculum categories were derived based on the listed learning objectives.

By referring to the learning objectives listed in the two categories for subjects, the syllabus of relevant integrated subjects in dental education in the Republic of Korea, the syllabus of relevant integrated subjects in dental hygiene education in other countries, and Kim's study[11], which presented the required courses and their learning objectives in the dental hygiene curriculum, the learning objectives and weekly learning content for the integrated curriculum were derived. In addition, after checking and summing the hours required to complete each learning content by referring to the syllabus, the credits for the integrated subject, and the year and semester of completion were derived by referring to the prerequisite subject and learning content.

3. Delphi survey on competency-based integrated curriculum

1) Selecting experts for Delphi surveys

A Delphi survey was conducted to assess the validity of the competencies and integrated curriculum derived from this study. The Delphi survey was conducted twice with 15 experts who were full- or part-time professors with teaching experience in the courses Anatomy, Histology & Embryology, or Physiology in dental hygiene departments in Seoul, Gyeonggi-do, Gangwon-do, Gyeongsangbuk-do, Gyeongsangnam-do, Busan, Chungcheongnam-do, and Daegu.

2) Evaluating the validity of competencies for integrated curriculum

The validity evaluation for the competencies of the integrated curriculum was conducted with a questionnaire consisting of closed-ended questions that asked for ratings on a 5-point Likert scale for content validity, clarity, difficulty, and importance, as well as open-ended questions for expert panel comments[14-17].

To produce the results, content validity was calculated and compared based on five analysis criteria, including the content validity ratio (CVR), content validity index (CVI), degree of convergence, and degree of agreement[18]. For CVR, the number of experts was 15, so a CVR value of 0.49 or higher was considered valid[15,19]. A CVI value of 0.78 or higher was considered valid if the number of experts was 10 or more[20]. A degree of convergence of 0.5 or less and a degree of agreement of 0.75 or more were interpreted as high agreement and low disagreement on the analysis criteria. Clarity, difficulty, and importance were determined using the mean and standard deviation of the responses, with higher means indicating greater clarity, difficulty, and importance[21]. The competencies were revised and supplemented based on the results of the analysis criteria and other opinions from experts.

3) Evaluating the relevance of an integrated curriculum

The questionnaire for evaluating curriculum relevance consisted of questions on learning possibility, unity, systematicity, and efficiency, referring to the criteria of integration developed by Kim and Hong[22], and questions on quantity and level, which were items suggested in Kang's study[23] for analyzing the adequacy of educational content, were rated on a 5-point Likert scale (Table 1).

To analyze the relevance of the integrated curriculum, the percentage of positive responses and the mean of responses for each assessment question were identified[24].

Table 1. Assessment Questions for Integrated Curriculum Relevance

Category	Question
Quantity	Is the amount of learning in the integrated curriculum appropriate for the credits?
Level	Is the content of the integrated curriculum appropriate for the student's cognitive level at the time of introduction?
Learning possibility	Is the learnability of the integrated curriculum high?
Unity	Do the learning topics within the integrated curriculum have unity?
Systematicity	Do the learning topics in the integrated curriculum have sequence and continuance?
Efficiency	Does the integrated curriculum enable competencies to be achieved more effectively?

The curriculum was revised and supplemented based on the results of the analysis and expert opinions.

After revising the content to reflect the results of the first Delphi survey, a second Delphi survey was conducted with the same experts and evaluation questions as the first Delphi survey to investigate the validity of the revisions made to the first Delphi survey. The results of the second Delphi survey were interpreted and processed in the same way as those of the first Delphi survey, and the competencies and integrated curriculum were derived.

Results

1. Validity for competency

The results of the first expert Delphi survey of the competencies showed that the values for all four content validity analysis criteria (CVR, CVI, degree of convertgence, and degree of agreement) for five of the nine competencies were rated as valid (Table 2). Of the four competencies that satisfied the analysis criteria for content validity, the competency "Can utilize knowledge of the normal structure and function of the head and neck in the dental hygiene assessment and diagnosis process." was retained, and the other three competencies were modified or deleted in consultation with the researchers, based on other opinions from experts, as follows: The competency "Can utilize knowledge of the normal structure and function of the human body in the dental hygiene assessment and diagnosis process" was revised because there was consensus from multiple experts that the learning content regarding the normal structure of the human body was insufficient. Competencies with the phrase "in the oral cavity" were revised to "oral cavity" due to expert opinion that the phrase should be changed. The competency "Can utilize knowledge of the morphology and characteristics of lost tissue in the oral cavity for patient care and treatment." was removed because multiple experts opined that it was difficult to achieve using only this integrated curriculum.

Of the nine competencies, the remaining four were removed because neither the CVR nor CVI values were met.

For clarity, with the exception of one competency, all competencies scored 4 or higher, indicating that they were written appropriately in clear and understandable terms.

Difficulty scores ranged from 3.8 to 4.33, with the highest for "Can utilize knowledge of the normal structure and function of the head and neck in the dental hygiene assessment and diagnosis process" and "Can utilize knowledge of pain and paresthesia that occurs in the head and neck and oral cavity for patient care and treatment," and the lowest for "Can utilize knowledge of the structures in the oral cavity to take impressions and make models."

In importance, with the exception of one competency, all competencies scored 4 or higher, with the highest for "Can utilize knowledge of the normal structure and function of the oral cavity in the dental hygiene assessment and diagnosis process."

In the second Delphi survey, competencies that were retained and modified were re-evaluated with the same evaluation questions as in the first Delphi survey, and for competencies that were deleted, agreement with the deletion was confirmed with the evaluation question "Is the deletion of this competency appropriate?"

Of the four competencies that were retained and revised, three were confirmed as valid because the values for all analysis criteria (CVR, CVI, degree of convergence, and degree of agreement) for content validity were met. The revised competency, "Can utilize knowledge of the normal

Table 2. Results of Delphi Surveys on Competencies for an Integrated Curriculum

Competency	Delphi survey	Content validity				Clarity	Difficulty	Importance	Agreement to remove
		CVR	CVI	Degree of convergence	Degree of agreement				
1. Can utilize knowledge of the normal function of the human body in the dental hygiene assessment and diagnosis process.	1st	0.60	0.80	0.5	0.75	4.33±0.72	4.20±0.68	4.33±0.90	
	2nd	0.47	0.73	0.75	0.63	4.00±0.93	4.20±0.56	4.40±0.91	
2. Can utilize knowledge of the normal structure and function of the head and neck in the dental hygiene assessment and diagnosis process.	1st	0.87	0.93	0.5	0.80	4.47±0.52	4.33±0.82	4.73±0.46	
	2nd	0.73	0.87	0.50	0.80	4.27±0.80	4.40±0.63	4.80±0.41	
3. Can utilize knowledge of the normal structure and function of the oral cavity in the dental hygiene assessment and diagnosis process.	1st	0.73	0.87	0.5	0.80	4.67±0.49	4.20±0.68	4.80±0.41	
	2nd	0.87	0.93	0.25	0.90	4.67±0.49	4.47±0.64	4.93±0.26	
4. Can utilize knowledge of anatomical structures on radiographs in dental radiographic examinations.	1st	0.07	0.53	0.75	0.63	4.40±0.74	4.00±0.38	4.53±0.74	
	2nd								3.87±0.92
5. Can utilize knowledge of pain and paresthesia that occurs in the head and neck and oral cavity in dental hygiene care and treatment.	1st	0.60	0.80	0.25	0.88	4.40±0.63	4.33±0.62	4.47±0.74	
	2nd	0.60	0.80	0.50	0.75	4.27±0.88	4.33±0.62	4.47±0.64	
6. Can utilize knowledge of the morphology and relationships of tissues in the oral cavity to apply materials and instruments.	1st	0.33	0.67	0.5	0.75	3.60±0.91	3.93±0.70	3.93±1.10	
	2nd								4.53±0.64
7. Can utilize knowledge of the morphology and characteristics of lost tissue in the oral cavity for patient care and treatment.	1st	0.60	0.80	0.25	0.88	4.13±0.74	4.13±0.83	4.47±0.64	
	2nd								4.20±0.77
8. Can utilize knowledge of the structures in the oral cavity to take impressions and make models.	1st	0.33	0.67	1	0.50	4.33±0.90	3.80±0.56	4.40±0.74	
	2nd								4.00±0.85
9. Can utilize knowledge of the range of anesthesia-induced paresthesia in patient care and treatment.	1st	0.20	0.60	1	0.50	4.27±0.70	3.93±0.46	4.27±0.80	
	2nd								3.87±0.83

Values are presented as mean±standard deviation.
CVR: content validity ratio, CVI: content validity index.

Table 3. Results of Delphi Surveys forIntegrated Curriculum

Integrated curriculum	Delphi survey	Quantity		Level		Learning possibility		Unity		Systematicity		Efficiency	
		%	Mean	%	Mean	%	Mean	%	Mean	%	Mean	%	Mean
1. Structure and Function of the Human Body & Head and Neck	1st	20.0	2.60	60.0	3.47	66.7	3.53	93.3	4.40	73.3	3.93	66.7	3.87
	2nd	60.0	3.80	86.7	4.13	80.0	3.93	93.3	4.53	80.0	4.07	80.0	4.00
2. Structure and Function of the Oral Cavity	1st	33.3	2.87	73.3	3.73	80.0	3.93	100.	4.53	80.0	4.13	80.0	4.13
	2nd	53.3	3.73	100.	4.33	80.0	4.00	86.7	4.47	73.3	4.00	80.0	4.27

%: positive response rate.

function of the human body in the dental hygiene assessment and diagnosis process." was not met for any of the analysis criteria for content validity. Several experts commented on the lack of relevant learning objectives for this competency.

For clarity, all four competencies were scored 4 or higher and all competencies were evaluated as clearly described.

The difficulty and importance scores were also above 4 for all competencies, and "Can utilize knowledge of the normal structure and function of the oral cavity in the dental hygiene assessment and diagnosis process" was the highest in difficulty and importance.

When the means and standard deviations were confirmed for the five deleted competencies, the mean was greater than 3.8 (Table 2). These competencies were finally removed based on the value of the agreement to remove them and other expert opinions that the competencies were not achievable through this integrated curriculum alone.

2. Validity for the integrated curriculum

This study derived two integrated curricula. In the first Delphi survey, the integrated curriculum Structure and Function of the Human Body & Head and Neck had a positive response rate of less than 75% and a mean of less than 4 for all assessment questions, except for the unity question (Table 3). In particular, for the quantity question, all experts commented on the following: "There is a lot of learning content compared to credits" and "There are not enough credits to complete the learning content."

For the integrated curriculum of Structure and Function of the Oral Cavity, the values for systematicity, unity, and efficiency indicated validity. However, the quantity question had a 33.3% positive response rate and a mean of 2.87, with comments such as "There is a lot of learning content" and "Not enough credits."

The second Delphi survey was conducted on the revised integrated curriculum using the same evaluation questions as the first Delphi survey. For the integrated curriculum Structure and Function of the Human Body & Head and Neck, the values of all the assessment questions increased. Nonetheless, for quantity, the percentage of positive responses was less than 75%, the mean was less than 4, and the mean for learning possibility was less than 4.

Table 4. Course Outlines for Structure and Function of the Human Body & Head and Neck Curriculum Developed in This Study

	Course outline
Year/semester	1/2
Credit (Lecture-Lab)	4 (4-0)
Competency	1. Can utilize knowledge of the normal function of the human body in the dental hygiene assessment and diagnosis process. 2. Can utilize knowledge of the normal structure and function of the head and neck in the dental hygiene assessment and diagnosis process. 3. Can utilize knowledge of pain and paresthesia that occurs in the head and neck and oral cavity in dental hygiene care and treatment.
Learning purpose	Based on the knowledge of the normal structure and components of the human body and head and neck, with a clear understanding of the normal function of each organ in the human body and the relationships between them, abnormal structural and functional changes in the human body and head and neck can be identified and their causes, including birth defects, can be evaluated in an integrated approach.
Prerequisite subject	Biology, Chemistry

For the Structure and Function of the Oral Cavity, all the assessment questions increased in value, with the exception of systematicity and unity. Although the value increased in quantity, the percentage of positive responses was less than 75% and the mean was less than 4. Systematicity showed a positive response rate of less than 75%.

3. Competency-based integrated curriculum

After the first and second Delphi surveys, through a process of revisions to the draft of competencies and integrated curriculum, a final competency-based integrated curriculum was developed (Table 4～7).

Discussion

1. Interpretation

This study developed competencies for dental hygienists that can be achieved from Anatomy, Histology & Embryology, and Physiology courses in the field of basic dental hygiene, and developed an integrated curriculum based on these competencies. As a result, four competencies and two integrated curricula were established.

Of the four competencies developed, for the competency “Can utilize knowledge of the normal function of the human body in the dental hygiene assessment and diagnosis process,” the values of some assessment questions did not meet the standard criteria for validity. However, since Anatomy, Histology & Embryology, and Physiology are courses that study the human body, and Physiology in particular addresses the normal function of the various tissues or cells that make up the human body, competency was determined to be closely related to the characteristics of the subject itself and was finally derived in consultation with the researchers[11]. The experts who disagreed with the content of the competency suggested a lack of relevant learning objectives as a reason; therefore, it was determined that the learning objectives needed to be supplemented rather than the competency. The remaining three competencies were derived in a form whose validity was agreed upon by all the experts during the first and second Delphi surveys.

The clarity, difficulty, and importance scores were above 4 for all four competencies, suggesting that the competencies developed in this study were well expressed in clear terms and with important content. Since the competency “Can utilize knowledge of the normal structure and function of the oral cavity in the dental hygiene assessment and diagnosis process” had the highest level of difficulty, an integrated subject to achieve this competency, Structure and Function of the Oral Cavity, may be assigned after the Structure and Function of the Human Body and Head & Neck integrated subject in the curriculum sequence[16].

After the first Delphi survey, based on the values and expert opinions of the assessment questions, the competencies that required an understanding of the subjects, such as Morphology, Pathology, and Clinical Dentistry in addition to the courses Anatomy, Histology & Embryology, and Physiology, were removed. However, as with basic

Table 5. Learning Contents for Structure and Function of the Human Body & Head and Neck Curriculum Developed in This Study

Week	Content topic	Learning goal
1	Subject Introduction: Properties of the human body	• Can understand the subject. • Can explain properties of cells, tissues, and organs. • Can explain properties of living organisms. • Can explain homeostasis in living organism.
2	Cells and Tissues in the Human Body: Epithelial and connective tissues	• Can explain types and functions of cell organelles. • Can explain process of mitosis in cells. • Can explain intracellular metabolic processes. • Can explain structure and function of cell membranes. • Can explain cellular material transport. • Can explain properties of epithelial tissue. • Can explain properties of connective tissue.
3	Bones comprising the head and neck	• Can distinguish the skull and facial bones. • Can explain properties of cartilage tissue. • Can explain structure and properties of bone tissue. • Can explain functions of bones. • Can explain the terminology related to bone surface structures. • Can enumerate the individual bone comprising the skull. • Can enumerate types and quantities of the skull. • Can enumerate types and quantities of facial bones. • Can explain structures observed in the mandible. • Can explain change in mandibular angle with age. • Can explain position of the incisive foramen and mental foramen with age.
4	Bones comprising the head and neck	• Can explain structures observed in the maxilla. • Can explain structure and function of maxillary sinuses. • Can explain structures observed in the palatine bone. • Can explain structures observed in the sphenoid bone. • Can explain structures and surrounding muscles in the temporal bone. • Can explain structures observed in the zygomatic bone. • Can explain structures observed in the parietal bone.
11	Blood vessels comprising the human circulatory system and head and neck	• Can explain properties of blood vessels and lymphatic vessels. • Can explain the heart. • Can explain the blood circulation as systemic circulation and pulmonary circulation. • Can explain the components and functions of blood. • Can explain structure and function of red blood cells. • Can explain types and functions of white blood cells. • Can explain the mechanism of blood coagulation. • Can explain the automaticity of the heart. • Can explain the blood pressure.
12	Functions of human body: Respiration, Metabolism, Digestion	• Can explain the terms related to respiration. • Can explain structure and function of the respiratory system. • Can explain the ventilation mechanism. • Can explain the gas exchange between alveoli and tissues. • Can explain the transport of oxygen and carbon dioxide in the blood. • Can explain the relationship between energy metabolism and body temperature. • Can explain the concept of metabolic rate and the conditions of basal metabolic rate. • Can explain the mechanism of thermoregulation. • Can explain the components and actions of gastric juice. • Can explain the components and actions of pancreatic juice. • Can explain the components and actions of bile. • Can explain the function of the small intestine. • Can explain the function of the large intestine.

Table 5. Continued

Week	Content topic	Learning goal	Week	Content topic	Learning goal
5	Bones comprising the head and neck	• Can explain the sutures present in the skull. • Can enumerate the individual bone involved in orbital formation. • Can explain the blood vessels and nerves passing through the superior and inferior orbital fissures. • Can explain the structure of the ethmoid sinus. • Can explain the paranasal cavity. • Can distinguish the cranial fossa. • Can explain the types of fontanelles. • Can explain position and closure time of fontanelles.	13	Functions of the human body: Excretion, Internal secretion	• Can explain structure and function of the kidneys. • Can explain process of urine production in the kidneys. • Can explain the micturition reflex. • Can explain the internal secretion • Can distinguish the location and type of endocrine glands. • Can explain the physiological actions of pituitary hormones. • Can explain the physiological actions of thyroid hormones and related disorders. • Can explain the physiological actions of parathyroid hormones and related disorders. • Can explain the physiological actions of adrenal medulla hormones and related disorders. • Can explain the physiological actions of adrenal cortex hormones and related disorders. • Can explain the physiological actions of pancreas hormones and related disorders.
6	Muscles comprising the head and neck	• Can explain properties of facial muscles and masticatory muscles. • Can enumerate types of facial muscles. • Can explain actions of the orbicularis oris and buccinator muscles. • Can explain functions of the temporal muscle. • Can explain functions of the masseter muscle. • Can explain the functions of the internal and external pterygoid muscles.			
7	Muscles comprising the head and neck	• Can explain actions of the major muscles comprising the neck. • Can explain the actions of the medial and lateral pterygoid muscle. • Can explain the actions of the sternocleidomastoid muscle. • Can explain the actions of the platysma muscle. • Can explain structure of muscle tissue. • Can explain forms and functions of muscles. • Can explain the mechanisms of contraction and relaxation in skeletal muscles.	14	Human Embryology and Reproductive Physiology	• Can explain the anatomical structures of the male genitalia. • Can explain the anatomical structures of the female genitalia. • Can explain male and female hormones. • Can explain the process of fertilization and implantation. • Can explain formation process of bilaminar embryonic disc. • Can explain formation process of trilaminar embryonic disc. • Can explain developmental processes the ectoderm and the ectodermal organs. • Can explain developmental processes of mesoderm. • Can explain mesoderm and endoderm organs.
8	Midterm				

Table 5. Continued

Week	Content topic	Learning goal	Week	Content topic	Learning goal
9	Nerves comprising the head and neck	• Can enumerate perceptual, motor, and mixed nerves among the12 pairs of cranial nerves. • Can explain the nerves that contain parasympathetic nerve fibers among the 12 pairs of cranial nerves. • Can explain composition of the nervous system. • Can explain structure and function of neuron. • Can explain the mechanisms of excitation transmission between nerves and muscles. • Can explain types and functions of the autonomic nervous system. • Can distinguish types of reflex activities. • Can explain types and functions of the central nervous system. • Can distinguish types and sensory receptors of mechanical senses.	15	Finals	
10	Blood vessels comprising the human circulatory system and head and neck	• Can explain the route from the heart to the carotid artery. • Can enumerate the branches of the external carotid artery that distribute to the face and oral cavity. • Can explain the distribution area of the lingual artery. • Can explain the distribution area of the facial artery. • Can explain the distribution area of the maxillary artery. • Can explain the arteries that distribute to the masticatory muscles. • Can explain the veins that distribute to the face and oral cavity. • Can enumerate types of lymph nodes of the head and neck.			

Table 6. Course Outlines for Structure and Function of the Oral Cavity Curriculum Developed in This Study

	Course outline
Year/semester	2/1
Credit (Lecture-Lab)	4 (4-0)
Competency	1. Can utilize knowledge of the normal structure and function of the oral cavity in the dental hygiene assessment and diagnosis process. 2. Can utilize knowledge of pain and paresthesia that occurs in the head and neck and oral cavity in dental hygiene care and treatment.
Learning purpose	Based on the knowledge of the normal structure and components of the oral cavity, with a clear understanding of the normal function of each organ in the oral cavity and the relationships between them, abnormal structural and functional changes in the oral cavity can be identified and their causes, including birth defects, can be evaluated in an integrated approach.
Prerequisite subject	Biology, Chemistry, Structure and Function of the Human Body and Head and Neck

medicine, in order to ensure that basic dental hygiene education is applied in clinical practice and can lead to research, it is recommended that integration between basic dental hygiene subjects as well as integration with clinical dentistry or clinical dental hygiene related to basic dental hygiene is necessary[25].

In the relevance evaluation of the integrated curriculum, the results for quantity did not meet the criteria for validity until the second Delphi survey. There were differing opinions among the experts regarding the 4 credits. Some experts agreed that the credits were adequate, whereas others commented that 4 credits were insufficient because there were contents that were not in the existing learning objectives that should be addressed additionally and importantly in this integrated curriculum. Another expert stated that credits were insufficient because the courses Biology and Chemistry, which were presented as prerequisite subjects, were not separately organized as one subject in the overall curriculum and should be handled in this integrated curriculum. These opinions can only be addressed if the standardization of the dental hygiene curriculum and improvement of learning objectives are prioritized.

2. Key results and comparison

The competency-based integrated curriculum provides a link between the curriculum and the actual role by describing the competencies of dental hygienists and enables integrated thinking to solve problems in real situations; thus, it is a necessary curriculum for the training of dental hygienists in the current era that requires various new roles[26].

Understanding and solving patient problems requires integrated thinking based on the linkage of knowledge in basic dental hygiene; however, the basic dental hygiene curriculum is still fragmented with specialized subjects, similar to the dental curriculum[9]. In addition, previous studies have shown that the basic dental hygiene curriculum is less relevant to the competencies of dental hygienists than the total of 13 courses and 450 hours, and the need to reorganize the basic dental hygiene curriculum to increase the relevance of competencies and reduce the hours of operation were also presented[27]. An integrated curriculum can reduce unnecessary repetition of overlapping content and the number of credits and hours required and is expected to result in efficient utilization of credits and hours for the basic dental hygiene curriculum[26]. In addition, the low correlation with dental hygienist competencies can be improved by extracting basic dental hygiene knowledge and developing competencies related to the duties of a dental hygienist[27]. Therefore, this study was a specific example for the development of an integrated curriculum that solves these problems and strengthens the relevance of dental hygienist competencies.

3. Suggestion

Although not shown in the study results, the presence or absence of the courses Biology and Chemistry in the dental hygiene curriculum varied among universities. Similarly, a study that identified the dental hygiene curriculum at 10 universities in the Republic of Korea found that the same course was offered under various titles, and the lecture form and practice were not unified[28]. Learning objectives, which are used as a standard for organizing the educa-

Table 7. Learning Contents for Structure and Function of the Oral Cavity Curriculum Developed in This Study

Week	Content topic	Learning goal	Week	Content topic	Learning goal
1	Subject Introduction: Structure of the Oral cavity	• Can understand the subject. • Can enumerate the components of the oral cavity. • Can distinguish the oral cavity.	9	Tissues composing the Oral cavity: Salivary glands	• Can explain structure and types of salivary glands. • Can explain functions of saliva. • Can explain composition and properties of saliva. • Can explain the neural control of the salivary glands. • Can explain the mechanism of secretion of saliva. • Can explain diseases associated with saliva. • Can explain considerations for taking maxillary and mandibular intraoral radiographs. • Can explain normal anatomical structures found on intraoral radiographs. • Can distinguish abnormal anatomical structures found on oral radiographs.
2	Nerves comprising the oral cavity	• Can explain the branches and accessory ganglia branching from the trigeminal ganglion. • Can explain the components and major branches of the maxillary nerve. • Can explain the components and major branches of the mandibular nerve. • Can explain the components and functions of the facial nerve. • Can explain the ganglia associated with the facial nerve. • Can explain the major branches of the facial nerve.			
3	Nerves comprising the oral cavity	• Can explain the components and functions of the glossopharyngeal nerve. • Can explain the ganglia associated with the cranial nerve. • Can explain the components and functions of the vagus nerve. • Can explain the components and distribution of the lingual nerve. • Can explain the distribution of the ansa cervicalis.	10	Embryology of the mouth and teeth	• Can explain the processes forming the face. • Can explain formation of the lips. • Can explain formation of the nose. • Can explain formation of the palate. • Can explain causes of cleft lip and cleft palate. • Can explain features of Bud stage, Cap stage, and Bell stage. • Can explain the stage-specific features of dental hard tissue deposition and maturation.
4	Tissues composing the Oral cavity: Tooth	• Can explain properties of enamel. • Can explain formation and direction of enamel rods. • Can explain the growth lines of enamel. • Can explain properties of dentinocemental junction. • Can explain the structures found in enamel. • Can explain properties of dentin. • Can explain properties of dentin tubules. • Can explain the structures observed in dentin. • Can explain the types of dentin. • Can explain the neural control and the process of sensory transmission of dentin.	11	Embryology of the mouth and teeth	• Can explain formation of enamel and dentin. • Can explain ameloblast and odontoblasts. • Can explain formation of root • Can explain Hertwig's epithelial root sheath and epithelial rests of Malassez. • Can explain formation of cementum, periodontal ligament, and alveolar bone. • Can explain process of tooth eruption.

Table 7. Continued

Week	Content topic	Learning goal	Week	Content topic	Learning goal
5	Tissues composing the Oral cavity: Tooth	• Can explain functions and features of the dental pulp. • Can explain the cells present in the dental pulp. • Can explain the vascular and nerve distribution of the dental pulp. • Can explain the physiological actions of the dental pulp. • Can explain the chemical composition of the hard tissues of the tooth. • Can explain the physical properties of the hard tissues of the tooth. • Can explain the physiological actions of the hard tissues of the tooth. • Can explain the metabolism of the minerals comprising the tooth. • Can explain vitamin deficiencies in teeth. • Can explain the role of hormones in tooth formation. • Can explain the dentin-pulp complex.	12	Functions of the Oral cavity: Mastication	• Can define a temporomandibular joint. • Can explain structure and features of the temporomandibular joint. • Can explain the basic and functional motions of the mandible. • Can explain the terminology related to occlusion. • Can explain types and features of mandibular reflexes. • Can explain actions of the masticatory muscles. • Can explain function of mastication. • Can explain functions of the lips, cheeks, and tongue. • Can compare occlusal and masticatory forces.
6	Tissues composing the Oral cavity: Periodontal tissue	• Can explain properties of cementum. • Can explain the growth lines of cementum. • Can explain properties of dentinocemental junction. • Can explain primary and secondary cementum. • Can explain function of cementum. • Can explain the cells present in the periodontal ligament. • Can explain properties of the main fibers of the periodontal ligament. • Can explain function of periodontal ligaments. • Can explain properties of alveolar bone. • Can explain alveolar bone proper and supporting alveolar bone. • Can explain function of alveolar bone.	13	Functions of the Oral cavity: Sensory	• Can explain types and functions of sensory receptors in the oral region. • Can explain sensory of teeth. • Can explain sensory of the oral mucosa. • Can explain types of tastes. • Can explain distribution of taste buds. • Can explain chemical structures involved in taste. • Can explain taste tracts. • Can explain the olfactory receptors and structures. • Can enumerate anesthetic sites of the maxillary and mandibular nerves.

Table 7. Continued

Week	Content topic	Learning goal	Week	Content topic	Learning goal
7	Tissues composing the oral cavity: Soft tissues, palate	• Can explain the histologic features of the oral mucosa. • Can explain the tooth-gingival junction. • Can explain properties of free gingiva and attached gingiva. • Can explain structure and function of the gingival sulcus. • Can explain function of the gingiva. • Can explain types and characteristics of tongue papillae. • Can explain function of the extrinsic and intrinsic lingual muscles. • Can explain the neural control of the tongue. • Can explain function of the tongue. • Can explain the soft and hard palate. • Can explain the neural control of the soft palate.	14	Functions of the Oral cavity: Swallowing and vocalization	• Can explain the swallowing process. • Can explain causes and symptoms of vomiting. • Can explain causes of halitosis. • Can explain features and disorders of mouth breathing. • Can explain structure of phonatory organ. • Can explain formation of speech sounds. • Can explain dysphonia. • Can explain changes in the mandible following tooth extraction. • Can explain the anatomical structures that must be considered when making dentures.
8	Midterm		15	Finals	

tional content of courses and applying for the national examination, have not been revised since 2017[12]. Since standardization within dental hygiene education is a priority for the development and implementation of a successful integrated curriculum, it is necessary to develop a standardized curriculum that considers school systems (colleges and universities) and the latest learning content in the future.

Consideration is also needed regarding the form of operations. In basic medicine, experimental practice is indispensable for acquisition of basic medical knowledge because it can develop the ability to obtain objective research results and foster accurate judgment and effective application as a doctor. Studies have suggested that it is necessary to diversify and strengthen the practice content in the basic dental hygiene curriculum to increase the overall perception and satisfaction of the basic dental hygiene curriculum[9,25]. Therefore, it is necessary to develop practical content that enables operations along with the acquisition of knowledge in limited credits.

Since an integrated curriculum is student-centered and aims to strengthen problem-solving skills, it may require the introduction of student-participatory teaching methods such as problem-based learning[25]. There should be a change in student-participatory teaching methods for the basic dental hygiene curriculum because students can then indirectly experience clinical applications of the knowledge for basic dental hygiene[29-31].

4. Limitations

The competency-based integrated curriculum for basic dental hygiene developed in this study has the limitation of not achieving consensus among all experts on some of the assessment questions.

Notes

Conflict of interest

No potential conflict of interest relevant to this article was reported.

Ethical approval

This article was exempted from the Institutional Bioethics Committee of Gangneung-Wonju National University (GWNU IRB-2021-38).

Author contributions

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Data availability

Please contact the corresponding author for data availability.

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