The Development of Problem-Based Learning Module for Clinical Dentistry in Dental Hygiene

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We attempted to develop a problem-based learning (PBL) module for integrated education in dental hygiene with the aim of helping students gain clinical competencies necessary for dental hygienist work. To develop the PBL Module for Clinical Dentistry in Dental Hygiene course, the researchers identified literature related to not only educational technology, but also medical science, nursing, dentistry, and dental hygiene. During the design phase of the PBL module, problem scenarios and a plan for the teaching and learning process were developed. Developing problem scenarios involved describing a problematic situation and three questions related with that situation. To cultivate competencies required in dental clinics, each question was related to the diagnosis of a dental disease, dental treatment, and dental hygiene procedures for care. Teaching-learning process plan included the designs of operating environment, operational strategies, learning resources, facilitation of problem-solving process, and evaluation. It is necessary to evaluate the PBL module for integrated education in dental hygiene to confirm its effectiveness.

Key Words: Clinical dentistry, Education, Problem-based learning

Introduction

Dental hygiene education in Korea began with the introduction of a 2-year curriculum in 1965 by the Severance Hospital affiliated with College of Medicine at Yonsei University, which was based on dental hygienist training program from Fones School of Dental Hygiene in the United States. Contrary to the goal of dental hygienist training that focuses on preventive duties, dental hygiene education at the time consisted of theoretical and practical education on assistance for care[1]. In 1994, dental hygiene education throughout Korea was converted to a 3-year curriculum, and the development of a 4-year curriculum in 2002 has led to an extension of the schooling, along with an increase in the number of well-qualified dental hygienists to date[1].

Existing dental hygiene education has several problems, such as the content being excessively segmented into too many courses, the courses not being focused on dental hygiene, courses being dentistry-based, focusing on the duties of dental care assistance, without any consideration for the various roles that dental hygienists play[2,3]. Course-based education may lead to content overlapping with other courses or certain lessons not being taught based on the belief that these would be taught in other courses[4]. Moreover, because the curriculum progresses in no logical order, blended learning between courses becomes difficult, which limits the students' ability to build interdisciplinary integrative thinking[4]. Additionally, dentistry-based education has the goal of disease treatment, and its focus on dental care assistance duties differ from the duties of dental hygienists, whose goal is health promotion. This presents difficulties for the dental hygiene students in gaining comprehensive understanding and in applying what they learn to actual work situations. This ultimately leads to dental hygienists losing their profe-

ssionalism and identity[5,6].

Numerous studies on dental hygiene education have emphasized the need for the type of education that can improve students' problem-solving abilities by mutually linking theory and reality, and as a teaching-learning method, problem-based learning (PBL) was suggested[7,8]. PBL refers to a teaching-learning method of having the learner learn on his or her own through the process of solving given problems. The learner solves problems that may actually occur in real life through self-directed learning (SDL) and collaborative learning[9]. In this process, the learner thinks by connecting theory with reality, which develops comprehension, application, critical thinking, and the ability of task performance for the problematic situation, while also having an effect on learning-related motivation, interest, self-concept formation, cooperation, bonding, communication, and responsibility[10,11].

PBL was first used in medical schools, and it is currently being used in a variety of fields, including healthcare, mathematics, law, education, economics, management, sociology, and engineering[12]. In the field of dental hygiene, various abilities, such as interdisciplinary integrative thinking, critical thinking, and communication skills, are needed for dental hygienists to perform their professional duties in clinical settings, and PBL has been presented as a teaching-learning method for achieving such a goal[7,8]. There have been studies that developed problem scenarios or packages of PBL for some dental hygiene courses; however, studies that have analyzed the clinical duties of dental hygienists and course contents of available PBL modules are still lacking[13]. Accordingly, the present study aimed to present modules based on development of PBL problems and teaching-learning process plan to provide basic data needed for operationalizing PBL.

Materials and Methods

In this study, we developed a PBL module, to be used as a part of dental hygiene and clinical dentistry courses, instead of the existing educational methods. The PBL module developed in this study included the development of problem scenarios and a plan for teaching-learning process that are covered during one semester of the clinical dentistry courses. Problems for PBL development was based on practical understanding[9], while the teaching-learning process plan was based on PBL design model development for college courses[14]. The overall procedures used in the study are shown in Table 1.

1. Development of problems for PBL

1) Content analysis for problem development

The present study selected "dental disease" as the problem idea, after which, it conducted content analysis as a method of confirming learning content, learning goals, and clinical duties related to this idea. For the learning content, we used main topics from a total of 9 courses in oral medicine, oral and maxillofacial radiology, oral and maxillofacial surgery, pediatric dentistry, preventive dentistry, orthodontics, conservative dentistry, prosthodontics, and periodontology. These were taken from 1st and 2nd semester lecture plans posted on the intranet of Gangneung-Wonju National University, as of the end of September 2015. As for the learning goals, dental hygiene and learning goals[15] based on national examination items were used. As for the clinical duties, the 2nd dental hygienist job analysis report from the National Health Personnel Licensing Examination Board of Korea was used[16]. In addition to content analysis, we also referenced actual clinical data and various literature pertaining to PBL problems already developed, clinical dentistry, dental administration, dental insurance, diagnosis, and

Table 1. Design of the Research

Step	The process of research in this study
Step 1	Development of scenarios for PBL
1-1	Curriculum analysis
1-2	Create scenarios
1-3	Expert validity evaluation
Step 2	Development of teaching and learning process
2-1	Design of operating environment
2-2	Design of operational strategies
2-3	Design of learning resources
2-4	Design of facilitating problem-solving process
2-5	Design of studying evaluation

clinical cases.

2) Construction of problems for PBL

The problems for PBL determined the role of the learner so that SDL could be encouraged when the student recognizes he or she has the main role in problem solving. Problematic situations related to the idea (disease) that may occur in clinical hospitals and clinics were constructed based on the content analysis. After completing the construction of problems, problem-related learning goals and core competency and sub-competencies that can be gained after problem solving were presented through the development of competency-based dental hygiene education evaluation system[8].

3) Expert validity assessment

For the assessment of problems developed for PBL, 3 active professors from dental hygiene colleges in Korea and 1 outside expert who majored in education technology were invited and commissioned to perform the assessment. The expert assessment tool was comprised of 27 questions compiled from PBL problems validity assessment questions[17,18]. The expert assessment tool was distributed to the 4 invited experts, and the tool was constructed in a self-reporting questionnaire form with each question graded on a 5-point scale (strongly agree, agree, average, disagree, and strongly disagree). Expert validity assessment results showed an average score of 4.6 points. Highest scores were found in the order of practicality, ill-structured, and role of the problem. The problem development process was completed when all questions received a score of 4 points or higher.

2. Development of a teaching-learning process plan for PBL

1) Operating environment design

For designing the operating environment, the operating environment was determined by performing environmental analysis on temporal limitations of the teacher and learner and securing learning space among face-to-face, online, and blended methods. Subsequently, based on the operating environment, learning space was presented with consideration for physical space, such as classroom, laboratory, and lecture rooms, and online space, such as clubs, cafes, and blogs.

2) Operational strategy design

To design the operational strategy, the total learning period required for operating PBL was established; weekly activities were constructed; and time plan for activity contents was constructed. Weekly activities were divided into individual and team activities involving the teacher, tutor, and the learner. Theoretical learning issues that should be taught by the teacher during the course of the activities were presented together.

3) Learning resources design

Learning resources design presented learning resources related to the learning issues and confirmed the data used in content analysis, as well as other learning resources, including professional literature, actual objects, models, experimental tools, multimedia data, internet sites, professor lectures, and expert invitation.

4) Facilitation of problem solving process design

To facilitate the problem-solving process, the point of sharing the intra-group content, the point of verifying the inter-group output, the point of sharing need among all students, the point of providing feedback, and the process of task performance plan were properly structured. Moreover, usage data, such as group activities log, task performance plan, problem analysis log, and reflection journal that are needed at different time points were presented.

5) Assessment design

As for the assessment design, a decision was made to perform multi-source assessment by teachers and learners with assessment divided into process assessment that assessed the entire learning process and outcome assessment that took place at the end of learning. The assessment tool comprised of the assessment sheet based on content from literature related to existing PBL assessments.

Results

1. Development of problems for PBL

1) Analysis of learning content, learning goals, and clinical duties

As for the designer idea for PBL, dental decay was chosen among extracted keywords, because of its high-prevalence among outpatient cases commonly encountered in the clinical institutions in Korea. The results of content analysis were divided into examination and diagnosis, disease treatment, and dental hygiene care to organize the learning content, learning goals, and clinical duties. Among the 9 clinical dentistry courses selected for content analysis, 6 courses had content related to dental decay (Table 2).

2) Construction of problems for PBL

The role of a learner was defined as 1st year dental hygienist working in a dental hospital, while the problematic situation was presented as the visit to a clinical dental hospital or clinic by a patient with tooth ache. In total 3 problems were developed based on the content related to examination and diagnosis, disease treatment, and dental hygiene care as a result of the content analysis. The first problem presented content about consultation on the examination results after completion of diagnostic testing. The second problem presented content about patient education and dental care assistance duties during the disease treatment process. The third problem involved performing dental hygiene care according to oral care needs of the subject (patient) after examination. Learning goals and competencies were presented as problems that took into account the learning outcomes based on problem solving (Table 3).

2. Development of a teaching-learning process plan for PBL

Teaching-learning plan employed through the operating environment design, It was decided by mixing face-to-face classes and online use environment for assuming that there are no temporal or spatial limitations between the teacher and learner. The learning issues were presented after constructing the weekly activity and time plans based on the operational strategy design that would allow PBL to be operated 3 hours per week during a single semester (total of 15 weeks), and the learning resources design present the material used in the content analysis as the learning resources. As the design for facilitation of problem solving process, weekly planned content was combined and divided into activities. After checking that the points of sharing the intra-group content, verifying the inter-group output, need for sharing among all students, and providing feedback were adequately included in the curriculum, activity categories were divided into implementation, development, and completion. Subsequently, guidelines

Table 2. Analysis of Learning Contents, Learning Objectives, Clinical Job Content

Classification	Learning contents and objectives	Clinical task	Subjects
1. Examine and diagnosis	Examine and diagnosis process	History taking/vital sign measurement/ observe body/extra-oral assessment/ intra-oral assessment/dental hygiene diagnosis/dental hygiene plan	Oral medicine Conservative dentistry Dental radiology
2. Dental treatment	Conservative treatment procedure/cavity preparation & root canal treatment/restorative materials/prosthetic treatment/repair and removal of prosthetic devices	Conservation treatment/pediatric treatment/prosthetic treatment/impression and bite taking	Conservative dentistry Prosthodontics
3. Dental hygiene process	Dental hygiene diagnosis/tooth brushing/dentifrice/oral hygiene products/ professional plaque control/fluoride tropical application/sealant/caries activity test/smoking cessation/endocrine diseases/dry mouth/halitosis/diet and oral condition	Dental hygiene assess, diagnosis, planning, evaluation/preventive dental treatment/ oral medicine treatment/periodontal treatment	Oral medicine Preventive dentistry Periodontology

Table 3. Clinical Dentistry Problem-Based Learning Problem

Subject		Year 3/semester 2
		Clinical dentistry (integrated course)
Problem topic		Treatment and management of dental caries
Core competencies		Dental hygienists who graduate from the Department of Dental Hygiene should have knowledge and skills related to the clinical work required for their duties.
Learning objectives & Detailed competency	Problem 1	1. Describe the subjective diagnostic process 2. Explain the objective diagnostic process 3. Classify dental caries and dental disease and explain the cause, risk factors, and clinical symptoms of the disease. 4. Describe the treatment of dental caries and dental disease 1) Be able to utilize basic medical and dental clinical knowledge in patient management process.
	Problem 2	1. Dental care support services can be performed during the treatment of dental caries and dental diseases. 2. Patient management and patient education related to dental care can be performed. 2) Be able to perform tasks for effective dental care (impression taking, temporary attachment and removal, temporary filling and removal, orthodontic wire ligature and removal). 3) Be able to perform patient management and oral health education related to dental care.
	Problem 3	1. Based on the information gathered, it should be able to identify the oral health needs of the patient and perform dental hygienist judgment. 2. It is possible to establish the necessary dental hygiene intervention based on the judgment of dental hygienist. 3. The planned dental hygiene intervention can be performed and evaluated. 4) Based on the information gathered, the patient should be able to identify the oral health needs and to make dental hygienist judgment. 5) It should be able to establish dental hygiene plan by classifying into professional treatment and self-practice based on dental hygiene judgment.
Problem scenario		Dental hygienist △△△: It is the first year dental hygienist working at ○○ hospital. A man with a gray hair and a fleshy stomach comes in the hospital you work in with frown face. Dental hygienist △△△: (with a smile) Hello? Gil-dong Hong: Hi (frown). I came because of the tooth pain···. Dental hygienist △△△: Have you ever been treated at our hospital? Gil-dong Hong: (in a trembling voice) No, this is the first time. My right lower back was so sick that I could not sleep yesterday···. Dental hygienist △△△: (with anxious expression) When did you get sick? Gil-dong Hong: I felt uncomfortable from the last week, but I was not coming to dental hospital. I am really afraid of getting dental treatment···. What do I do···. I am so sick and painful···. I suddenly feel pain and it's getting worse···. Do I have to be cured? How is the treatment going···? I'm so nervous because I don't know anything about. I am wondering if there is anything I can do at home for oral health without treatment. Clinical chart/oral hygiene chart[a]
Problem 1		Gil-dong Hong finished patient examination and clinical examination and came back to the waiting room. Gil-dong Hong, why is his bottom right sick and what is his condition? Is there any other oral problem? What treatment should I receive in the future? I asked dental hygienist △△△ to explain with anxious face. Select a role that can appear in the dental clinic for each team, and produce and submit about 5 minutes of video with the content of the problem solving.
Problem 2		The dentist □□□ who diagnosed him by Gil-dong Hong requested to prepare the treatment of tooth #45 on the day. The dental hygienist △△△ thought that there was a lack of capacity to support medical care while preparing equipment and materials for #45 tooth. While I was wondering how to solve it, I thought that it would be helpful to create a manual related to dental hygienist's work and educational media necessary for patient education. If you are a dental hygienist △△△, please prepare the manual of the work which can be made in Hangul/Word and submit the educational medium which can be presented to the patient during the examination period in free form.
Problem 3		Gil-dong Hong, who has finished his care, wants to have his own oral cavity and hopes that he will not have any more problems, but he is worried about the situation that he is not well managed and continues to have problems with his oral health. He also requests help from dental hygienist △△△. If you are a dental hygienist △△△, what kinds of dental hygiene interventions can you suggest for the recovery or enhancement of dental health of Gil-dong Hong and how can you explain them to him? Please write the contents of each step of dental hygiene management process and lastly submit both the contents of dental hygiene intervention and explanation you have written.
Final product		Based on the results of the above-mentioned problem solving, organize the contents in accordance with the flow of the medical care process and the dental hygiene management process and submit them in the form of Power Point (PPT).

[a]Clinical chart/oral hygiene chart is used for the evaluation of oral health status by a dentist or dental hygienist in a dental hospital, which includes extra and intra oral examination as well as vital sign, overall health, the behavior of oral health, etc.

Table 4. Problem-Based Learning (PBL) Teaching Learning Process

Classification		Activities	Time	Check list		Learning issues
				Teacher	Student	
1 week						
Orientation & performance plan preparation	Introduction	Orientation for PBL	The instructor prepares and prepares a PBL Orientation PPT before problem PBL is implemented. Describe the role of students and teachers, guide learner role and use of the learning space, guide the teaching process and method, and solve preliminary questions.	30 min	☐		○ Understand the definition of PBL ○ Understand the difference between Existing Lecture Learning and PBL ○ Understand the PBL ○ Understand the PBL's effect
		Guide to organize group and distribution of group activities	Guides for grouping of less than 6 teams of 4 to 8 people considering free ride and professor's feedback activities. Even if the course is a large group, the group should be less than ten. Distribute group activities and guide group activities.	10 min	☐		
		Do group activities	The learner organizes groups for team activities. Define your team name, team rules, roles, etc., along with a brief introduction of each team, and then create a group activity sheet.	10 min		☐	
		Present scenarios	Teachers present problems to learners in a variety of ways (videos, photos, role plays, voice recordings, etc.).	5 min	☐		
		Guide to prepare the performance plan	For individual students, distribute an individual task performance plan form to each team, and assign a team task performance plan to each team to create learning objectives, core competencies, problem situations, problem solving, problem solving approach, and final product form.	5 min	☐		
	Development	Draft problem in the scenarios and preparing the performance plan	Students identify problem situations that need to read and resolve problem scenarios. Prepare a performance plan for the problem situation derived from the problem scenario, the learning objectives to be learned after solving the problem, the core competency, the problem solving method, the problem solving contents, and the final product form that the individual thinks.	20 min		☐	

Table 4. Continued

Classification		Activities	Time	Check list		Learning issues
				Teacher	Student	
1 week	Development	Make up the performance plan	In the process of sharing the contents of the individual task creation, we share opinions on how to solve the problem that can be solved by addition, and the feedback gathered in the team is one task Create a performance plan form, and finally determine the type of final product to be presented by your team.	30 min		☐	
		Submission of team work performance plan	Upload team work plan to the homepage of the department of dental hygiene.	10 min		☐	
		Presentation of team work performance plan	Provide a brief presentation of team performance plan by team so that they can share their opinions.	30 min		☐	
		Provide feedback on team performance plan	After checking that the problem situation and problem-solving approach derived by the learner are appropriate, explain the learning objectives and attainment capabilities related to the problem.	20 min	☐		
	Closing	Organize your lessons and explain the next course	Describe the course of problem 1, explaining the problem situation and the role of the learner. Explain the next PBL process to students.	10 min	☐		

Table 4. Continued

Classification		Activities	Time	Check list		Learning issues
				Teacher	Student	
2~3 weeks						
Solving problems and producing results	Introduction	Introduce learning goals and course	15 min	☐		Describe the learning objectives and instructional process related to problem 1

[Problem 1]
○ The diagnostic process
 - Patient's condition (history examination)
 - Clinical examination
○ The oral diseases
 - Classification of dental caries and dental diseases
 - Causes of illness, risk factors, clinical symptoms
 - Treatment for diseases
[Problem 2]
○ Treatment flow
○ The necessary procedure for treatment
○ Legal scope of dental hygienist
○ Clinical duties of dental hygienist
 - Dental care support: related to the treatment procedure, activities required for the treatment process, materials and equipment
 - Counseling and education-related: consultation about clinical symptoms, treatment process, precautions after treatment, oral health care habits
[Problem 3]
○ Understanding and applying the dental hygiene management process
 - Correlation between systemic diseases and oral health
 - Self-hygiene management method and professional management method of prosthetic patients with high risk of dental caries
 - Causes and treatment or management of bad breath
 - Causes of dry mouth and treatment or management method
 - Relationship between diet and oral health, diet counseling and diet prescription
 - Drinking and smoking cessation methods

Table 4. Continued

Classification		Activities		Time	Check list		Learning issues
					Teacher	Student	
2~3 weeks							
Solving problems and producing results	Development	Seeking team problem solving and producing output	To share the information and opinions that are searched by the individual within the team, and to organize the results of the problem solving in the problem analysis paper and to produce the intermediate result. If necessary during team problem solving, the contents of the team task performance plan can be revised and supplemented.	2 h		☐	
		Question and answer on problem-solving	The instructor will ask all learner questions related to problem1 and provide the answers including necessary learning contents.	30 min	☐		
	Closing	Organize your lessons and explain the next course	Explain the competencies that need to be achieved through problem solving, and guide the presentation of results.	15 min	☐		
4 weeks							
Presenting the results (interim presentation)	Introduction	Introduce PBL process on intermediate presentation	Explain PBL process on intermediate presentation about problem 1.	15 min	☐		
		Determine the order of intermediate presentation	The order of presentation is determined in a random way such as lot drawing, ladder riding, etc.	10 min		☐	
	Development	Present the results about solving problem 1	The result about solving problem 1 got presented to share and arrange the contents to other teams.	60 min		☐	
		Evaluate and provide feedback on presentation	The instructor conducts the process evaluation on the problem solving attitude, participation attitude and presentation after the presentation of all the teams and provides feedback based on the result. Provide the necessary learning resources if the learners have difficulties.	30 min	☐		

Table 4. Continued

Classification		Activities	Time	Check list		Learning issues
				Teacher	Student	
4 weeks						
Presenting the results (interim presentation)	Development	Devise solutions	The learner checks the activities in the team by referring to the contents of the feedback and the presentation of the other team, and corrects and complements the problem approach, problem solution methods.	50 min		☐	
	Closing	Organize your lessons and explain the next course	The instructor explains the learning contents and attainment ability that should be learned through problem solving in relation to problem 1, and explains the course of problem 2.	15 min	☐		

Problem 2 progressed for 5 to 7 weeks and problem 3 progressed for 8 ~ 10 weeks.
[a][Apply the same procedure to problem 2 and problem: Solving problems and producing results → Presenting the results (Interim Presentation)]

Classification		Activities	Time	Check list		Learning issues
				Teacher	Student	
11 ~ 13 weeks						
Synthesizing the problem solution	Introduction	Introduce learning goals and course	Describe learning objectives and instructional processes related to problem 1, 2, and 3	15 min	☐		
	Development	Complete the final results	Prepare the final results by summarizing the contents of problem 1, 2, and 3.	2 h		☐	
		Question and answer on problem-solving	The instructor will ask all learner questions related to Question 1 and provide the answers including necessary learning contents.	30 min	☐	☐	
	Closing	Organize your lessons and explain the next course	Explain the learning contents and attainment skills that you need to know through problem solving, and guide you through the next class. Guide the presentation of the final result (PPT) on the homepage.	15 min	☐		
14 weeks						
Presenting the results (final presentation)	Introduction	Introduce learning goals and course	Describe the final announcement process for problem 1, 2, and 3.	10 min	☐		

Table 4. Continued

Classification		Activities	Time	Teacher	Student	Learning issues
14 weeks						
Presenting the results (final presentation)	Introduction	Determine the order of final presentation	10 min		☐	
	Development	Present final results	60 min		☐	
	Closing	Make an evaluation	30 min	☐	☐	
		Provide feedback on evaluation	50 min	☐		
		Create a reflection log and guide the presentation	10 min	☐		
	Closing	Organize your lessons and explain the next course	10 min	☐		
15 weeks						
PBL finishing	Introduction	Guide the final exam	20 min	☐		
	Development	Final exam	60 min		☐	
		[Optional] lecture provided	60 min	☐		
	Closing	Provide final feedback	40 min	☐		

Activities (full text):

- Determine the order of final presentation: The order of presentation is determined in a random way such as lot drawing, ladder riding, etc.
- Present final results: The learner has a presentation time to share and arrange the contents of the corresponding state discrimination results among the teams.
- Make an evaluation: As well as the instructor (tutor), the learner participates in the evaluation process and evaluates the outcome of the result and evaluates the course of the learning process.
- Provide feedback on evaluation: After all teams have finished their presentations, the course evaluation is conducted in relation to problem solving, attitudes and participation in learning, and feedback is provided based on the results.
- Create a reflection log and guide the presentation: Create an individual reflection log and upload it to the homepage of the due date so that it can be submitted. Students who have difficulty in making journals for the first time by writing a reflection log will be presented with exemplary examples prepared by other students.
- Organize your lessons and explain the next course: The instructor will explain the learning contents and attainment ability that need to be learned through problem solving in relation to problem 1, 2, and 3, and will provide guidance on final exams.
- Guide the final exam: Allocate a final examination test sheet and explain precautions for the test.
- Final exam: Take the final exam by synthesizing the contents learned in the meantime.
- [Optional] lecture provided: If the learners have difficulties in learning, the instructor provides lectures.
- Provide final feedback: Provide final feedback on learning content and achievement capabilities based on evaluation and reflection logs.

Evaluation plan (①+②+③)
① Attendance 10%
② Professor/tutor evaluation 20%
③ Learner evaluation (=self-assessment+in-group evaluation+intergroup evaluation) 50%
④ Final exam 20%

were established by including activities log, task performance plan, problem analysis log, and reflection journal needed for activities, and then categories for performing each activity were presented separately for teachers and learners. Finally, assessment design was used to present attendance, teacher evaluation, learner evaluation, and written final exam as the assessment items, and the percentages for each assessment item were established (Table 4). Moreover, the assessment tool was presented to allow the teacher and learner to perform multi-source assessment (Table 5).

Discussion

A dental hygienist refers to a professional who works to promote oral health, and the role of a dental hygienist has become more important in changing from a treatment-centric to a preventive care-centric role to keep up with the changing trend over time[16]. However, current dental hygiene curriculum has educational content that is divided based on dentistry courses, which makes interdisciplinary connection difficult. Because it involves top-down method of delivering fragmentary knowledge and skills for license acquisition, the opportunities to gain integrative understanding about the actual work situations and the application of such knowledge and skills are limited. Consequently, there are difficulties in gaining the necessary competencies to perform the basic duties of a dental hygienist[19]. Therefore, with this study, we present the development of a PBL module that included problem scenarios and teaching-learning process plans to be incorporated into clinical dentistry courses, PBL module provides the basic information for an integrative dental hygiene education that would allow learners to gain the competencies needed in the clinic.

Dental decay, a high-prevalence disease among outpatient cases in Korea, was selected as the problem scenario for the PBL module that was developed. Then, contents of the curriculum and clinical duties were verified. Learning content, learning goals, and clinical duties related to dental decay were analyzed, and the findings were taken into account when developing the 3 problems based on the flow of examination and the dental hygiene care pro-

cesses, while presenting the learning goals and competencies at the same time. The significance of the present study is that by developing PBL problems that took into account the curriculum and clinical duties, it was designed to allow acquisition of theoretical concepts about disease and treatment process, along with gaining comprehensive understanding of the disease and treatment process through problem solving, then applying the theoretical concept during actual duties. The learner should be able to obtain new knowledge via PBL by connecting concepts that are handled in various different clinical dentistry courses. Ultimately, the learner, as a future dental hygienist, must also gain comprehensive and professional job competencies and knowledge to apply when needed in clinical setting during their actual duties. It is expected that during the process of problem solving, the learner would not only integrate the various concepts that he or she understood through SDL and collaborative learning to create knowledge, but also would develop various job competencies, such as comprehension, application, critical thinking, task performance abilities, cooperation, bonding, communication, and responsibility[20-22]. The problems developed in the present study took into account the clinical duties of dental hygienists and dental hygiene and clinical dentistry curricula of Korea in recent years. However, those problems cannot cover all of the learning contents of clinical dentistry courses and clinical duties of dental hygienists; thus, development of additional problems is needed, as well as additional examinations to determine whether such problems developed are being reflected in actual clinical situations.

The present study is also significant because it provided actual help for operating PBL by constructing a teaching-learning process plan. The teaching-learning process plan included the entire class schedule, location, and learning resources. Moreover, operating PBL was made easier by the present guideline based on dividing the weekly activities by time, dividing the activities by who is performing them, and including usage data. Furthermore, assessment plan was established based on various assessment subjects and the necessary tools were presented to allow multi-source assessment. However, prior to operating PBL, operational decisions need to be made based

Table 5. Problem-Based Learning Assessment Tool

Subject	Evaluation contents
Professor/tutor evaluation	1. Did all members of the team faithfully attend the class?
	2. Did you understand your role in the problem solving process?
	3. Did you organize the contents of problem solving to achieve the learning objectives and competencies?
	4. Was there a variety of problem-solving approaches to problem situations you had found?
	5. Did you use appropriate evidence to derive valid problem solving?
	6. Did you collect the necessary data for problem solving, analyze it, and create various knowledge through the process?
	7. Was the outcome of the problem based learning unique and practical in clinical practice?
	8. Was the results of your work faithfully written with the team's diverse opinions?
	9. Was the presenter well aware of what were the problems in each scenario and how to solve it?
	10. Were the presenter ready for presentation (presentation, dress, posture, voice, accent, etc.)?
Learner evaluation (self-assessment)	1. Did you attend the class with exactly knowing problem based learning process and evaluation methods?
	2. Were you interested in the problem based learning process and sincerely involved in the class?
	3. Had you identified problems with the problem and sought various solutions?
	4. Did you collect, analyze, and organize your own data for individual tasks?
	5. Did the problem based learning process develop the competencies needed to solve problems such as problem analysis, logic, judgment, and critical thinking?
	6. Could you deal with similar real-world situations by learning the knowledge, skills, and attitudes necessary to solve the problems during the problem based learning process?
	7. Did you take responsibility for your role and did not you interfere with your team?
	8. Did you participate in the problem-solving process while respecting and collaborating with team members?
	9. Did you make a lot of contributions to the problem-solving process and results?
	10. Did the problem based learning achieve the competencies required for the clinic?
Learner evaluation (in-group)	1. Did you offer a variety of ideas to solve your problem?
	2. Did you carry out individual assignments faithfully and share within the team?
	3. Did you perform responsibly and faithfully in your role in the team's activities?
	4. Did you contribute much in the problem-solving process?
	5. Did you make a lot of contributions in producing intermediate and final products?
	6. Did you keep the time well in your team activities?
	7. Did you follow all of your team-defined rules?
	8. Did not you interfere with team activities?
	9. Did you respect other people's opinions and encourage team atmosphere?
	10. Did you participate and actively participate in team activities?
Learner evaluation (intergroup)	1. Did you identify the core content of the problem and solve the problem?
	2. Did you find various solutions in the problem-solving process?
	3. Did you use the various resources in the problem-solving process?
	4. Was the information and materials you used clear and reliable?
	5. Did the information and materials you used persuasively explain the problem solving?
	6. Was the content of the problem solving creative?
	7. Was the content of the problem solving useful in a real situation?
Learner evaluation (intergroup)	8. Did the problem seem to be solved faithfully?
	9. Was the presenter aware of the problem and the way how to solve it?
	10. Are you ready for presentation (materials, dress, posture, voice accent, etc.)?

on determination of suitability and demand analysis for PBL. Additionally, it is also necessary to secure the necessary basic data for actual operation through the analysis of operating environment and learners to ensure smooth operation within educational institutions once a decision is made on using PBL[14]. Environmental analysis

should be performed to investigate time constraints, securing learning space, size of lectures, whether tutors should be used, and budgetary support to determine whether there are environmental factors that would place restrictions in using PBL. The alternative methods would be using online space[21]. Moreover, the level of the learner should be identified to adjust the difficulty level of the problems, and various learning methods, such as practicum, lectures, and videos should be used systematically to find ways to encourage class participation and increase the interest level for the lessons[22]. When multiple teachers or tutors are involved in the use of PBL, those teachers and tutors need to be trained in consistent and systematic manner prior to class. Furthermore, it should be kept in mind that when forming a team for collaborative learning, responsibility and collaborative learning may be easier with fewer team members than with a crowded team[23]. Lastly, further examination into when PBL should be applied is needed because having limited knowledge, rather than detailed knowledge, can maximize learning by triggering motivation for learning, stimulating curiosity for problem solving and that early education is ideal for achieving the goal of creative reasoning[24].

As for the recognition of dental hygienists' professionalism, competencies for professional knowledge and skills needed in actual field of work must be achieved systematically, for which, implementation of PBL has been suggested as one of the methods. However, studies on PBL within the field of dental hygiene are still lacking. The present study was significant because it analyzed existing dental hygiene curriculum and clinical duties in presenting problems. This may help learners gain the competencies necessary to perform their duties as professionals. The problems developed were used to design a teaching-learning process plan for incorporating PBL into clinical dentistry courses, which was also presented as a module. The limitation of this study is the fact that the problems and teaching-learning process plan for PBL were not developed in actual educational settings, and their effects were not tested. Therefore, in order to present future operation of standardized integrative courses on dental hygiene based on PBL, the demand for PBL should be identified. Additional studies are also needed in the future to test the usefulness and effectiveness of PBL by actually incorporating PBL into the dental hygiene curriculum.

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