



Development of Learning Simulation System for Dentistry Student (A case Study in Dentistry Students of Brawijaya University)

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Abstract

The development of science and technology, particularly computer science, has affected many fields including dentistry. Several learning methods were applied to develop the clinical reasoning of prospective dentists. This clinical reasoning has not yet facilitated the evaluation of student clinical reasoning. This study was aimed at designing a learning evaluation system which could measure the level of clinical reasoning of prospective dentists and provide evaluation assistance in clinical reasoning test of prospective dentist at Faculty of Dentistry Brawijaya University (FKGUB), Malang. An Object Oriented Analysis and Design (OOAD) method was used. A CodeIgniter (CI) framework with Model, View, Controller (MVC) model was used. Results showed that 91% students received some learning and clinical reasoning test by using PINUS. This indicated that students felt comfortable and they enjoyed using PINUS as it was easy to follow. In addition, PINUS could also develop investigation and determine clinical reasoning performance of the students.

Keywords: *Clinical Reasoning, Learning Evaluation system, Simulation Learning*

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INTRODUCTION

The development of science and technology, particularly in computer science is very rapid. This has affected many fields including dentistry. Dentistry curriculum is required to include clinical reasoning. Clinical reasoning is a thinking process showing how information contained in clinical cases and experience are used to help diagnose or manage patients' problem. Dentistry curriculum also accurately studies clinical pathological condition of oral diseases [7].

Clinical reasoning is a cognitive process which is difficult to describe, show, and assess. Clinical reasoning makes use of computer simulation technology based on interactive screen of real clinical scenario, namely Virtual Patient (VP). VP is made for health, medical training, education, or assessment purposes. For assessment, it simulates the meeting between medical professional and patient [2] [16]

VP learning simulation is designed for prospective dentists when they are following an education program giving them little chance to interact with patients. Interaction in the form of simulation is created in several models such as *Computer Assisted Learning (CAL)*. CAL is an effective interaction model in various learning topics [4] [11]. In addition, it is a good model to be used in the design, implementation, and evaluation of autism therapy [14].

Furthermore, e-learning makes learning easy for students [1]. [15] also developed e-learning programs through computer-based case simulation to help prospective dentists practice drawing conclusion. The conclusion about patient's diseases is drawn based on complete patient data. Problem Based Learning (PBL) is another learning method created in 2006. This method facilitates knowledge relevant with student skill and attitude [5].

However, there are problems found in these three learning models. These models do not show feedback of users' answers with answers stored in database. In addition, there is no gap and assessment of the results of the simulation program. As a result, prospective dentist can only use the simulation without knowing their skill level as suggested by [3] that VP is not only for learning but it is also for clinical reasoning skill assessment. Based on the above notions, in this study, a case learning system which can give feedback and student clinical

reasoning skill assessment was developed. This system was called PINUS and applied at the Faculty of Dentistry, Brawijaya University (FKGUB), Malang. PINUS was developed by using a *CodeIgniter (CI)* framework with a Model, View, *Controller (MVC)* concept. *CodeIgniter* was developed and maintained by *expression engine development team* [13].

STUDY METHODOLOGY

The stages of the study included data collection, analysis, resources identification, system design, and system verification and validation. Primary data consisting of patient personal data, chief complaint, health history, teeth health history, general medical examination, subjective examination, objective extraoral examination, intraoral examination of general condition, intraoral objective examination, radiology examination, and complete blood count [2] [16], were collected from FKGUB Malang.

In analysis stage, infrastructure analysis, user analysis, and requirement analysis were conducted. Infrastructure analysis was done to assess the facilities available in FKGUB Malang to support students' learning. User analysis was done to assess what activities can be done by users to the system. Meanwhile, requirement analysis was done to assess the requirements found in the development of system. Analyzes done in this study were aimed at making planning stage and system implementation stage easier to do.

System design stage was the stage when the system was designed based on the analyzes done in the previous stage. In order to save money and facilitate system development, system was developed by using an open source platform [10]. [12] The system was designed by using an Object Oriented Analysis Design (OOAD) approach by using usecase and class diagrams. Microsoft Visio 2010 application was used in this system design.

Verification and validation stage was the stage when the system function was assessed by using a black box testing method which was usually called a functional test [9]. In a functional test, users did not have access to the internal details of the application. Inputs were selected based on the requirement specifications given by previous users and were defined in the analysis stage of a software development [8]. After the verification and



validation stage was done, PINUS system was implemented by using cloud computing.

examination, intraoral examination of general condition, intraoral objective examination, radiology examination, and complete blood count.

RESULTS AND DISCUSSION

1. Data Collection

Secondary data were collected from patients of FKGUB Malang lecturers and Permata Bunda Hospital Malang. These data included patient personal data, chief complaint, health history, teeth health history, general medical examination, subjective examination, objective extraoral

2. User Analysis

PINUS users were students and administrators. Students could take clinical reasoning practicum test in accordance with the system command. Administrators could do PINUS data management. Description of activities of PINUS users is listed in Table 1.

Table 1 Activities of PINUS users

User Category	Task
Student	View tutorial, help, about, login, list of patient Take Training Take exam View exam result Take remedial exam
Administrator	Do login Manage exam Manage patient, user

Analysis of Infrastructure at Faculty

Adequate facilities for computer-based learning and exam as listed in Table 2 were found at FKGUB Malang.

Table 2 Infrastructure in FKGUB Malang

FKGUB	
Web	1. <i>HTTP://old.fk.ub.ac.id/id/</i> 2. <i>HTTP://pdg.fk.ub.ac.id/en/</i> 3. <i>HTTP://vlm.ub.ac.id/</i>
Facility	1. Academic rooms 2. Control Academic and Counseling Service 3. Talent and Interest Service (Extracurricular) 4. Medical Record Skill (Tramed) and Tooth Skill Laboratories 5. Internet connection with a bandwidth of 185 Mbps in Tramed Laboratory. 6. Library in Dentistry Study Program with about 10,000 collection of books, journals, research reports, and reports of student final assignments and patient data in previous researches.

Requirement Analysis System

Requirement analysis system revealed that for PINUS development, softwares including Windows 10, MySQL 5.6.25, PHP 5.6.11, Google Chrome 43.0.2357.130, Microsoft Visio 2010, and StarUML 2.5.1. were requirement. For system development,

hardwares consisting of Laptops with the specification of Toshiba L510, Intel(R) Core(TM) i3 CPU M370 @ 2.40 GHz 64-bit, Memory 4 GB, Hard disk 250GB were requirement

3. System Design

System Architecture

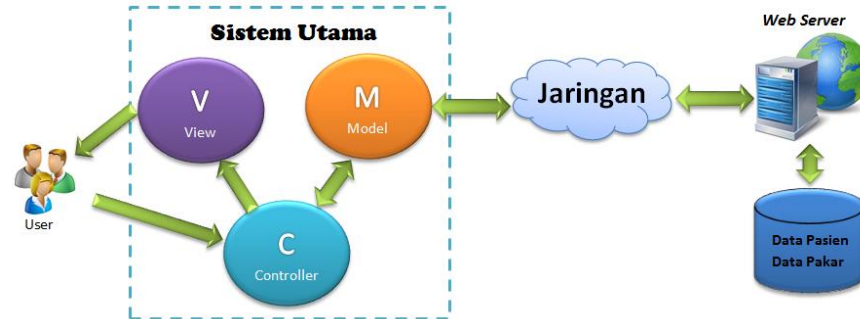


Figure 1 PINUS Architecture

This learning system was designed by using a CI framework architecture with a Model, View, and Controller (MVC) model. The MVC model was applied in the system to achieve the objectives of this study. [6] in the integration of web-based knowledge management for learning course, the design model put the stress more on the integration of modules in a learning course system.

Learning Model

The whole VP functions developed by [16] were almost similar to those of PINUS. However, there was no assessment so that students could not know their clinical reasoning mark. Therefore,

PINUS was developed with assessment function to improve students' clinical reasoning skill. This was in accordance with the suggestions given by [3] that in the further study, students did not only learn but they could also get assessment to know their clinical reasoning level.

Based on this notion, in this study, a learning and exam model was developed by combining results of the study by [16] and suggestions from [3]. This study focused on designing a system for learning and exam which contained assessment of clinical reasoning of students of FKGUB Malang as depicted in Figure 3.

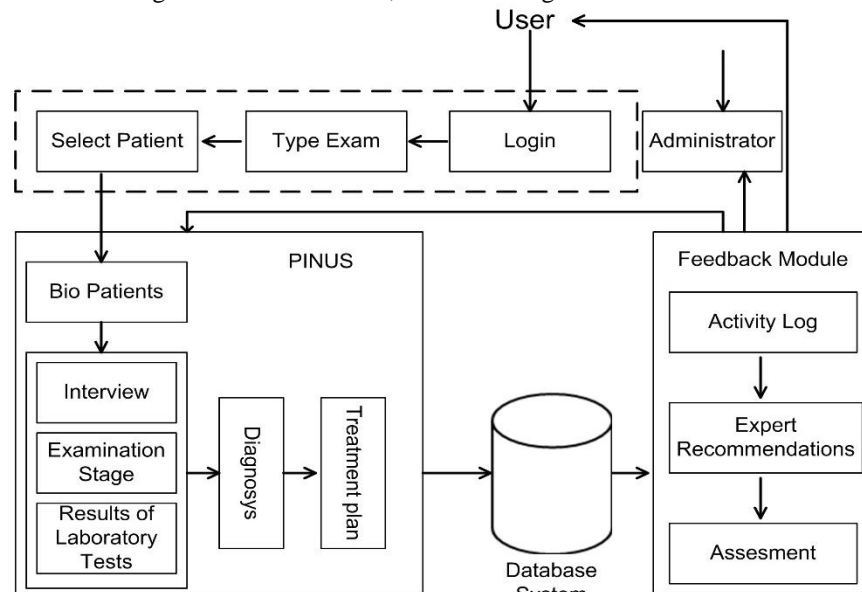


Figure 2 PINUS Interface

Usecase Diagram

Based on the analyzed learning and exam model, a tool was requirement to objectively

determine the general role and function of actors and system. Usecase diagram was the tool used to design

this learning system.

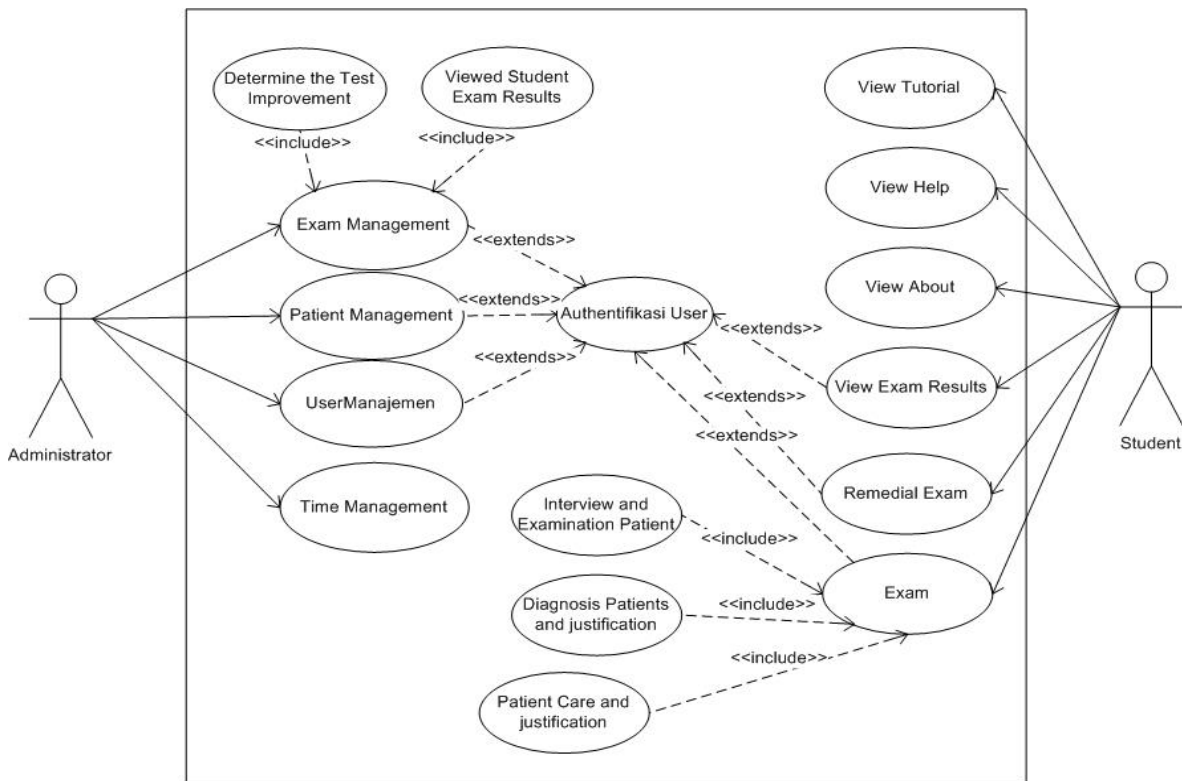


Figure 3 PINUS Usecase Diagram

Administrator and students were the actors involved in the system. Interaction between actors and function in the system was described by using a usecase diagram as shown in interface design in Figure 3. Administrator and students could interact with certain and different functions.

Class Diagram

Class diagram is a class describing and illustrating the structure of some kinds of objects in a system with various occurring static relationships. In this design, the class diagram consisted of several classes including administrator and student as the actors conducting a process. This process was elaborated into several classes as objects such as learning system and exam system.

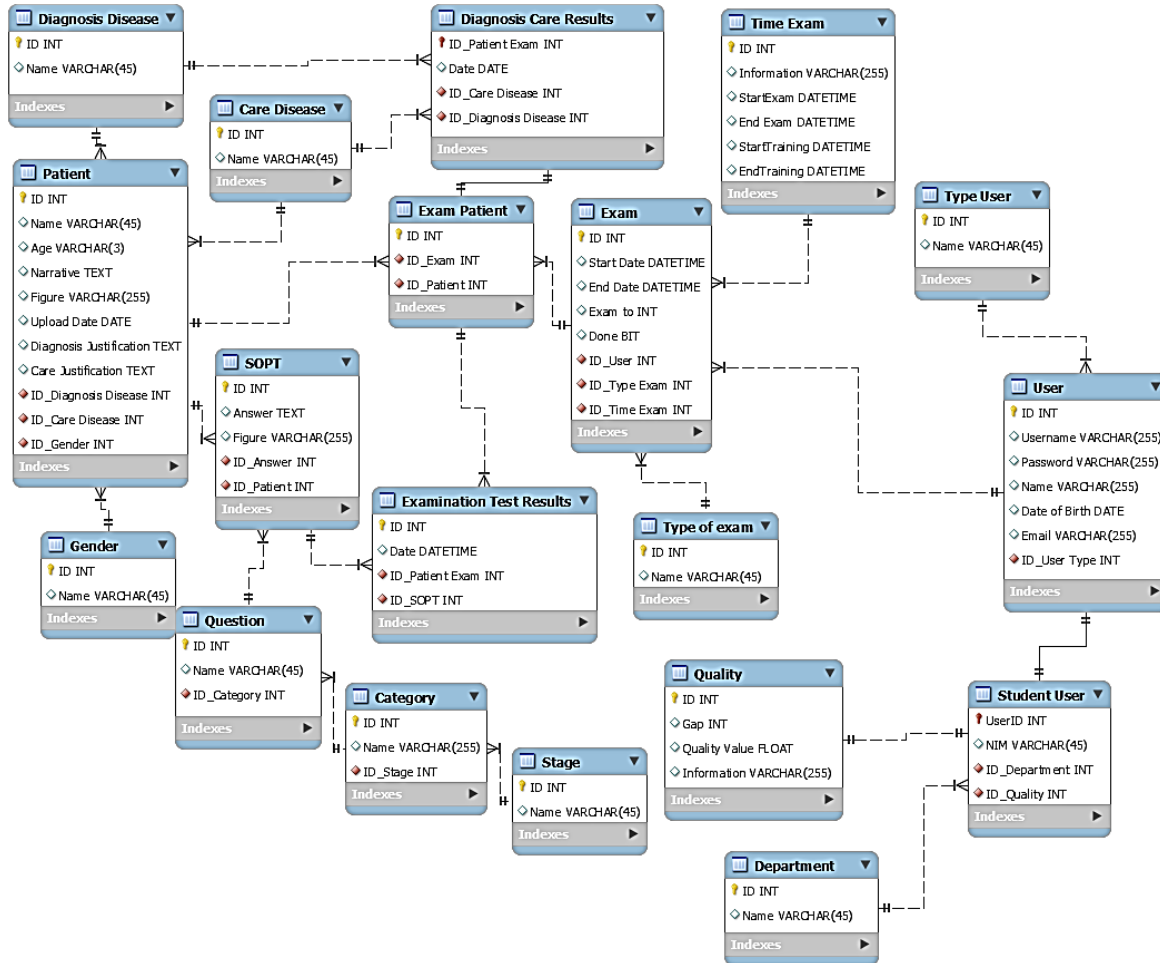


Figure 4 PINUS Class Diagram

4. Verification and validation

Before it was implemented, PINUS was verified and validated. The test was done to ensure that PINUS system functioned as expected. The test was done to the functions of the system described in

design stage. The test was done by using a black box method by creating a test scenario in the forms of inputs and assessing whether the outputs were as expected. The list of the test is shown in Table 3.

Table 3 PINUS Black Box Testing

No	Name of test	Result of test
1.	User Authentication	Successful
2.	View home, tutorial, about, patient waiting room, exam result	Successful
3.	Management of user, patient	Successful
4.	Management of time	Successful
5.	Management of exam	Successful
6.	Logout	Successful
7.	Take learning, exam, and remedial exam	Successful

No	Name of test	Result of test
8.	Select Type of exam	Successful

5. Implementation

System implementation stage was done after results of the previous analyzes and design were obtained. The system was developed by using PHP

programming language and MySQL database. The display page of examination, diagnosis, and patient treatment plan stages is depicted in Figure 5.

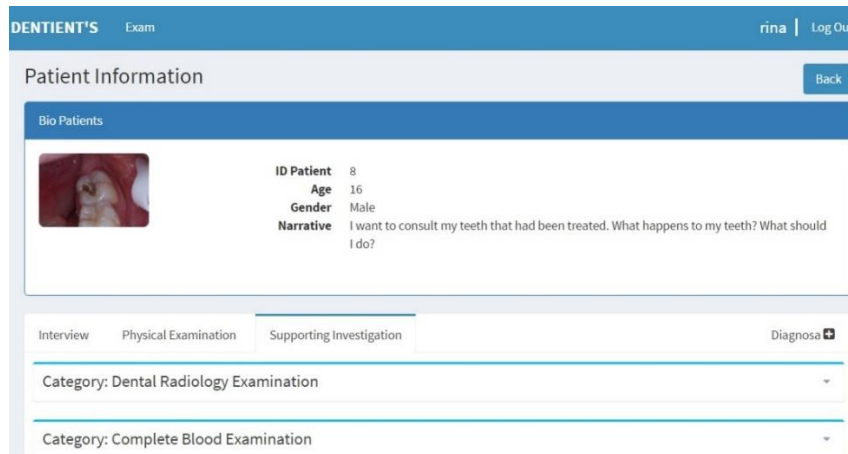


Figure 5 Testing Stage

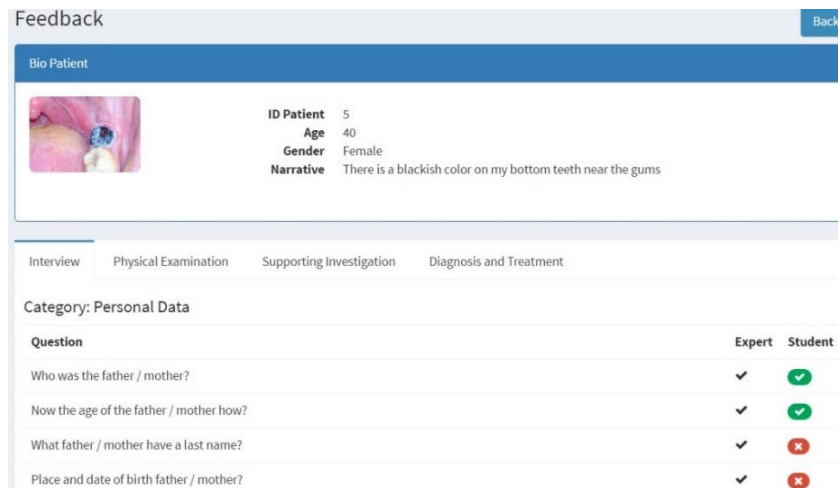


Figure 6 PINUS Feedback



ID Pasien	Kategori	Nilai	Nilai Target	GAP	Ketulusan	Ketulusan Final
4	Data Diri	2	4	-2	L	TIDAK LULUS
	Keluhan Utama	1	7	-6	TL	
	Pemeriksaan Subjektif	2	5	-3	L	
	Pemeriksaan Radiologi Dental	1	1	0	L	
	Riwayat Medis	1	5	-4	L	
	Riwayat Gigi	1	7	-6	TL	
	Pemeriksaan Darah Lengkap	1	1	0	L	

Figure 7 Training Final Mark

The feedback which was done is depicted in Figure 6. In addition, send button also functioned to send results of done stages by students to database. As mentioned in the objective, this system was developed to facilitate students in improving their clinical reasoning skill when they handle patients' cases and measuring their clinical reasoning skill, and to facilitate lecturers in assessing the students' clinical reasoning skill. Figure 7 and Figure 6 show the objectives of the system by displaying the feedback system in student answer and assessment of student clinical reasoning skill for lecturers.

6. Conclusions

The objective of this study was to systematically develop a web-based PINUS. The development of PINUS which was aimed at assessing the clinical reasoning skill of prospective dentists in virtually handling real patient cases in FKGUB Malang was successfully implemented. PINUS was

developed by using an OOAD method implemented by using cloud computing. Results of data analysis showed that overall, this system was requirement by FKGUB Malang. This system was developed to achieve the learning and exam objectives so that it could improve student competence. PINUS was developed not only for learning but also for the assessment of clinical reasoning.

7. Recommendations

PINUS was not only developed in this study. It was expected that further studies be done to develop PINUS which gave not only diagnose and therapy, but also feedbacks. Further development could be done to make PINUS able to give medical advice to students so that they know how to avoid the disease. In addition, it was expected that PINUS be able to be applied in other medical disciplines, not only in dentistry.

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