Design and Implementation of Computer Based Test (CBT) in vocational education

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Abstract. This research is motivated by an analysis of the needs of the examination system that still uses conventional methods that require considerable time, cost, and effort and have not been able to synergize with technological developments. Research on the development of Computer Based Test (CBT) Models Based on the web aims to develop a CBT model that can overcome the problems found in conventional tests. This type of research is development research (R & D) with software development procedures using the waterfall model. The stages of development consist of the needs analysis phase, the design stage, the implementation phase, and the testing phase. Research respondents were students of the Information Systems study program. The results of this study were obtained online test kits to help the process of evaluating student learning outcomes with features: input test data, display an analysis of the completeness of the report, and print reports made for the completion of the learning assessment. By using a database system, this online exam makes it easier for the exam system to display questions and assessments, making it easier for users to use it and for administrators to manage questions.

1. Introduction

The development of the flow of technology and information and communication in the 21st century demands a change in the educational process because most of the work usually done by humans at this time has been carried out by machines with increasingly sophisticated technology [1]–[3]. The shift of the 21st-century learning paradigm that has the characteristics of learning includes learning in free space, independent and collaborating, learning with digital materials, learning to use information technology, and electronic communication media resulting in the need for balancing in educational and learning programs [4]. This is done to balance the conditions and challenges of the 21st century, including paradigms and challenges in the world of work that are full of unlimited business competition, doing business by collaborating and forming networks, doing business by selling ideas and doing business by utilizing digital media [5]–[7].

Digital transformation marks the rise of the industrial revolution era 4.0. all fields apply digital technology, education and the world of work [8]–[10]. The work process that used to use human skills can be done more effectively utilizing sophisticated digital devices. Automation in the world of work can eliminate jobs while creating new jobs. The world of work really requires highly skilled and specialized human resources [11]–[14].

Learning evaluation is a series of activities consisting of measuring and evaluating something based on certain criteria and aspects to determine decisions in learning. Learning evaluation activities related

to the learning process and learning objectives [15]. The learning process is designed and arranged based on the objectives to be achieved [16]. Evaluation is done to find out the desired learning objectives. Therefore also the tools or instruments for evaluating learning are tailored to the learning objectives.

A proper evaluation is an evaluation that meets the requirements, including validity, reliability, and practicality [17]. Validity refers to the ability to produce valid data, reliability has the meaning as a test determination in producing data, and practicality refers to administrative ease, time is given, ease of scoring, ease of interpretation and application, and the availability of available evaluation instruments [18]–[22]. Comparable. Based on the opinion of these experts, in general, it can be concluded that to state a valid test can be viewed from various components namely the validity and reliability[23]–[25].

Conventional exams use paper and stationery as support for exam activities. Useful for making exam questions, doubling exam questions, exam evaluations, and others. This results in a lack of paper efficiency and time effectiveness of the test. In evaluating learning outcomes, conventional exams that have been running are seen to be less effective because they consume a lot of cost, time, place, and personnel. The cost, in this case, is the number of funds spent by the school to provide exam documents such as photocopies of exam questions. Time, in this case, is the length of the stages of work and reporting of exam results. In conventional examinations, it cannot be separated from the evaluation process and students' grade data reports, which are carried out manually one by one. In conventional evaluations do not provide evaluation results in real-time. Students and parents have to wait for days to find out the results of the evaluation, whether their children passed/did not take the competency test at school.

This problem is not by the procedural assessment process of student competency, the validity and reliability of questions are very awake and confidential, there is no human error factor in the evaluation process of the exam, the efficiency of the assessment process both in terms of the use of paper and stationery, the effectiveness of the exam time which does not take up a long time in an examination process for achieving student competency.

Communication and electronic technology have developed so rapidly that the education sector has also experienced an increase in quality, speed, practicality, and also convenience. Conventional exams have also shifted towards computerization, one of which is the online exams. With the advent of the internet, computers can be connected to form a vast network of thousands of computers throughout the world. Anyone who has access to the network can exchange information with various forms of text, images, sounds, files, and so on. Moreover, this network can be accessed for 24 hours.

Evaluation with online systems has advantages that are not possible to obtain in evaluations with manual systems or conventional evaluations, namely the speed of processing results. Judging from how to correct the form of questions in the conventional system has advantages if the form of questions used to test is the form of description, the teacher will more easily assess student learning outcomes that are actually in accordance with student competencies and deficiencies in the online examination system will be very difficult to correct questions in the form of description. In an online evaluation in its use, the system provides evaluation results in real-time. The results of the evaluation are immediately known right then and there when someone ends the exam without having to wait for days. Online exams are divided into two types, namely web-based exams and online desktop exams. The disadvantage of the desktop version of the online exam is that each time you take an exam, the teacher must reset it from the configuration of the online exam application. So it can take quite a long time to prepare for desktop-based online exams.

Computer-based test as the use of computers in tests and assessment of student learning outcomes. Testing and assessment of student learning outcomes refer to standards and classifications [26]. Some research on computer-based tests have produced recommendations that the learning objectives and CBT, namely fun and entertaining, educating, and challenging [27]. CBT is effective and provides a challenge for users to work on questions and complete tests in a reasonable and timely manner [28]. CBT provides several advantages over the implementation of tests with a paper and pencil test model, including an automatic scoring system and reducing the burden on respondents or test takers because it is easier to

work on [29]. CBT is also useful in diagnosing skills gaps and knowledge but also measures progress and evaluation [30]. The growth of online-based learning challenges educators to provide quality education [31], [32].

Computer Based Test is a test with an implementation system using a computer as a medium for conducting tests. The presentation and selection of CBT questions are made in a computerized manner so that each participant who does the test gets a different set of questions. Examination with the CBT system or Computer Based Test certainly has a difference with the Paper Based Test system in terms of the working media. Examinees using an awkward CBT system can choose the correct answer on a computer screen, but using a paper and pencil test system, the students is required to discolor the dots on the answer sheet paper.

This system was developed to minimize cheating or leakage of questions that often occur during exams, prevent question limitations, damage to questions so that results are not released after being examined. The CBT system will reduce the cost of implementation because, of course, there is no need to print questions and answer sheets with paper, question distribution, escorting questions from the security forces and reduce the cost of correcting exam results by scanning answers sheets and scoring that requires more time.

Also, the exam with the CBT system is more practical, easier, and makes the examinees more focused. No complicated and more time-saving because it does not need to spend a long time filling in the answer sheets, no need to delete if something goes wrong, there is no error in filling out the personal data, and the question code. There is time on screen so that you can maximize the time available. The more effective in working on problems, of course, the more questions can be answered and indeed the possibility of graduation is also greater.

2. Method

This research uses research and development methods (Research and Development) and uses a waterfall development model. The research and development steps are undertaken in this study refer to the Borg and Gall research stage with adjustments [33]. The first stage is a needs analysis, and this stage is the initial stage that contains data collection that starts with observations made by researchers to see the problems that exist in the field. Activities in this stage include observation and interviews [34]. Observation is to make observations directly to the object of research to look closely at the activities carried out. An interview is a method of collecting data that is used to obtain information directly from the source [15]. From interviews and observations conducted, it can determine the objectives, requirements, and system specifications needed.

The next stage is the design process, which includes a series of steps to describe all aspects of the software being built. The aspects produced in this stage include the representation of data, architecture, interfaces, and procedures. The design consists of database design, architectural design, and interface design.

Database design is based on system requirements and how the relationship between data is based on system requirements and specification information. The design at this stage will be implemented on the web-based Online Testing System. This architectural design uses the Unified Modeling Language (UML) notation, which includes several stages such as Use Case, which consists of actors and actions they can take. In the development of CBT, use case diagrams explain the relationship between the system with administrators and users. The class diagram illustrates the CBT structure of the classes that will be created in building this system. Class diagrams consist of class names, attributes, and operations contained in them.

Interface Design Based on the architectural design that has been formed, the interface design is made up of two views, namely for the admin view and ordinary user display. The design is made to adjust the function of the type of user. Admin Interface Design (Dashboard) includes a CBT display design that is accessed by the Admin. Procedural design occurs after data, architectural design, and interfaces are built. In an ideal world, procedural specifications are needed to specify algorithmic details that will be expressed in a language.

The implementation phase is in the form of realizing the existing design so that an online examination system is formed that is ready to use. The implementation process carried out in this web-based development. The testing phase is carried out in 4 stages, namely Unit Testing Stage: white-box testing is carried out by testing each module that works in the system. Integration Testing Phase: carried out by tracing two or more interconnected units, whether they are in accordance with the work plan. System Testing Stage: black-box testing is carried out by testing each function's checklist on the system by an expert.

3. Result and Discussion

3.1. System Analysis

System analysis is needed to improve data processing procedures and study in more detail. The purpose of the ongoing system analysis is to determine the shape of the new system design will be applied to replace the old system in part or as a whole. Make the system work well; the old system (the system that is running) must be updated by making a new system design that can provide better results than the old system. Where the new system is a system that will overcome the weaknesses of the old system. Find out the weaknesses of the old system. It is necessary to do a system analysis of the old system.

Conceptually, the meaning of system analysis is testing a whole information system into smaller component parts with the aim of identifying and evaluating problems, opportunities, and obstacles that occur and the needs needed so that it can be improved.

Based on the analysis carried out on the old system, it is found in the flow of the new information system, and there are changes made to the old information system. These changes are mainly in the data processing. The form of this new information system flow can be seen in Figure 1.

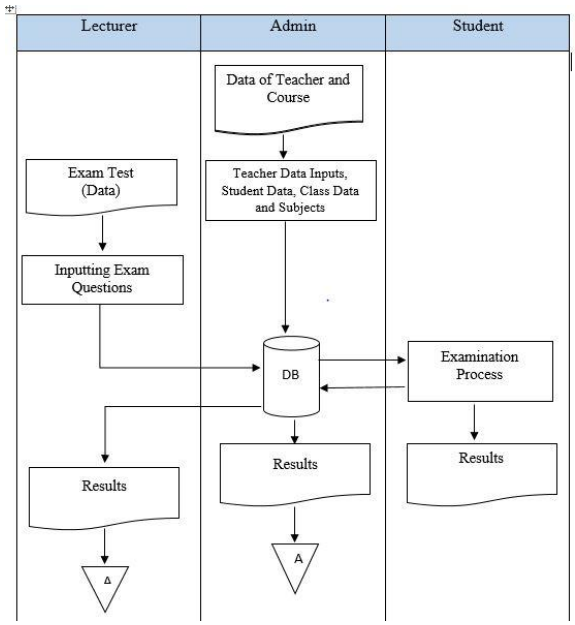

Fig. 1 New Information System Flow

3.2 System Design

At the system design stage, a systematic approach is carried out to identify problems, opportunities, and goals, analyze the flow of information in organizations, and to design computerized information systems to solve a problem. As information develops, a systematic and planned approach to introducing, modifying, and maintaining information systems becomes essential. The analysis and design of the system display such an approach.

In the hold of this system design, the system design is divided into two stages, namely the global design stage and the detailed design. This system design is used to design a system that will be used in

the new information system, and the new system design is expected to facilitate the work of the user. System design tools used are using UML.

UML is one of the tools/models for designing object-oriented based software development. UML itself also provides a standard for writing a blueprint system, which includes the concept of business processes, writing classes in a specific program language, database schema, and the components needed in a software system.

Global design is an overview of the system in the outline or in general. In this global system, the design will show the structure or flow of the system to be designed. The purpose of global design is to make it easier to do detailed design, besides giving a general description to the user or leader about the new system produced. To do system design, generally used tools or system development tools such as Use Case Diagrams, activity diagrams, class diagrams, and sequence diagrams.

Use Case is an activity or also a continuous interaction between actors and systems, in order to develop software/information systems, in order to obtain the functional needs of the existing system. In this use case, it is designed to involve three actors, namely Admin, lecturer, and student. Use case This diagram illustrates the continuous interaction between actors and also the system, as shown in Figure 2 Admin, then log in and manage teacher data, student data, class data, test question data, exam schedule, and exam data, and when finished, press logout.

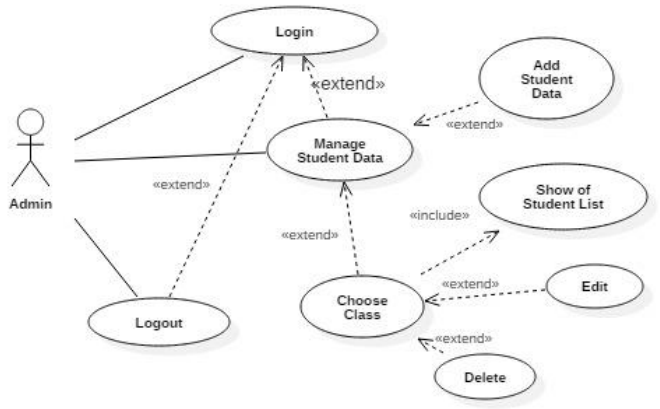

Figure 2. Use Case Diagram Admin

The activity diagram illustrates the workflow or activity of a system or business process or menu that is in the software. Activity Diagram illustrates the running system activity. Activity diagrams are used as an explanation of program activities without looking at the code or display. In this system, three activity diagrams are designed, namely student activity diagrams in processing exam questions, lecturer activity diagrams process question data, activity diagrams process value data.

In Student Activity Diagrams in managing exam questions, illustrated Students login by entering a username and password if it does not match then returning to the login if appropriate then enter the student homepage, then students take the test save, and there is also a delete menu if wrong and if it has been finished press logout as shown on figure 3.

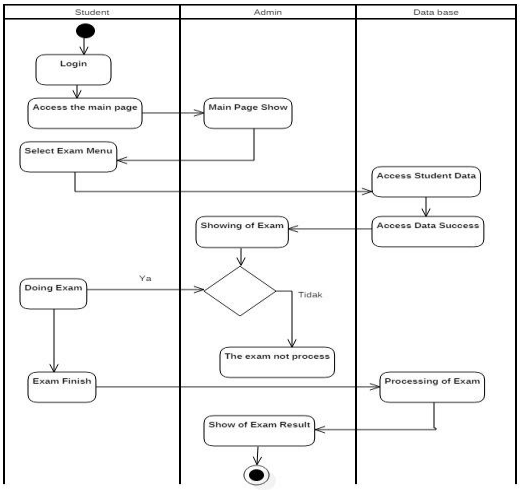

Figure 3. Student Activity Diagram manages exam questions

Sequence diagrams illustrate the relationship between objects in the use case by describing the time the object and the message sent between objects. To draw a sequence diagram, it is first known which object is involved in the use case along with the methods owned by the class. The login sequence is a login command scenario on the Computer Base Test application page. Users enter the login menu using the user name and password. From the login form, the user will check the user by entering the user name and password. The user name and password are processed to check their validity. This validity aims to open the main menu.

3.3 Design of Interface

CBT display design system which is divided into 3 (three) user category levels. The level of user categories is classified based on the functions of the online exam application users, including administrator users, teacher users, and student users. The following will describe three user category designs based on their classification level. The web-based online exam system is designed to have 3 (three) menus, namely administrator interface, teacher interface, and student interface. The front interface (home) in the online test system can be seen in Figure 4.

Figure 4. Main web Page

The administrator login page is the page that has the highest account level. An administrator can access all data that is in the web-based online exam application before administrators can access the application for online exam questions. Administrators are asked to enter a username and password code for the validity of the account. Figure 5, is the design of the administrator login page, on this page, there are 2 (two) keys that function as keys to enter the administrator page, namely the username and password.

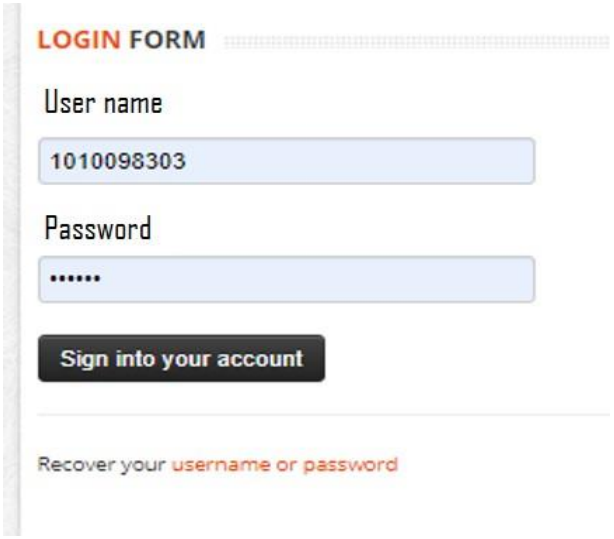

Figure 5. Login Form

The process of activating students into e-learning can be done in two ways, namely: Activation through the Admin, the Admin, will register students to e-learning according to the number of lectures followed by students, by first verifying the data of students who have completed their obligations and have filled in study plan card. The second activation method is done by students themselves through the registration menu, and student data will automatically be available on e-learning if the student has filled out a study plan card.

User is a term for everyone who has access to e-learning in accordance with their position. Users in e-learning have several levels, including Administrators, Lecturers, and Students. One of the roles of Admin is to add users to e-learning. Adding users can be done by the Admin one by one or can also be done simultaneously in large numbers. The method adopted by the registration settings applied by the Admin, namely email-based user registration and manual registration by the administrator. In e-learning using manual registration by Admin, so users other than administrators cannot register other users.

Lecturer Data Menu contains facilities to manage Lecturer Data in the system. This lecturer data will be synchronized with the data in the Academic section. Lecturer Data menu will display a menu like a Figure 6, and this menu can be added and edited the name of lecturers who have registered on the system

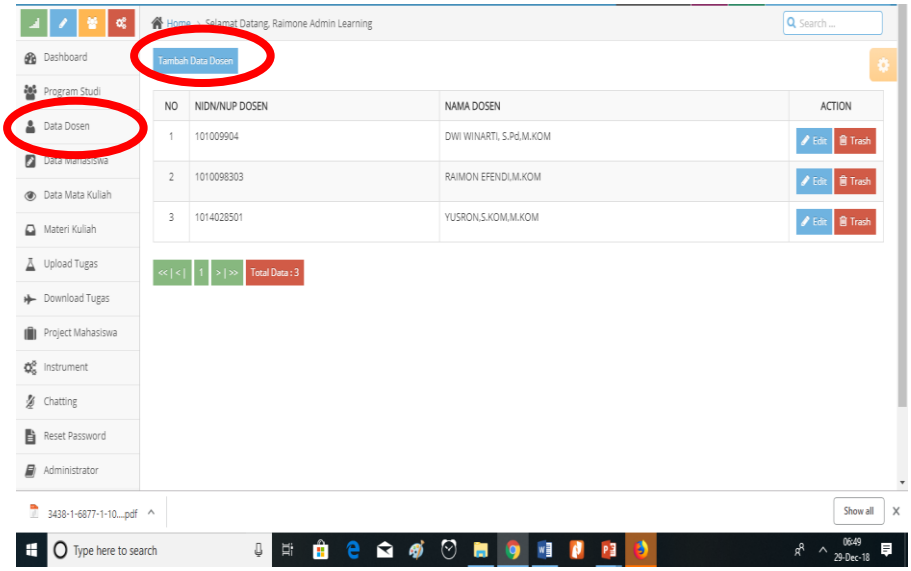

Figure 6. Lecturer Menu

Online exam menus are all forms of exam activities that can be used to do weekly tests, midterm exams, and final semester exams. The management of the exam is carried out by the Admin as the highest authority in the e-learning system, and it will function as the manager and monitor of the Online exam. Menus managed in the Online exam are shown in Figure 7. The online Management menu there are several functions, as in table 1.

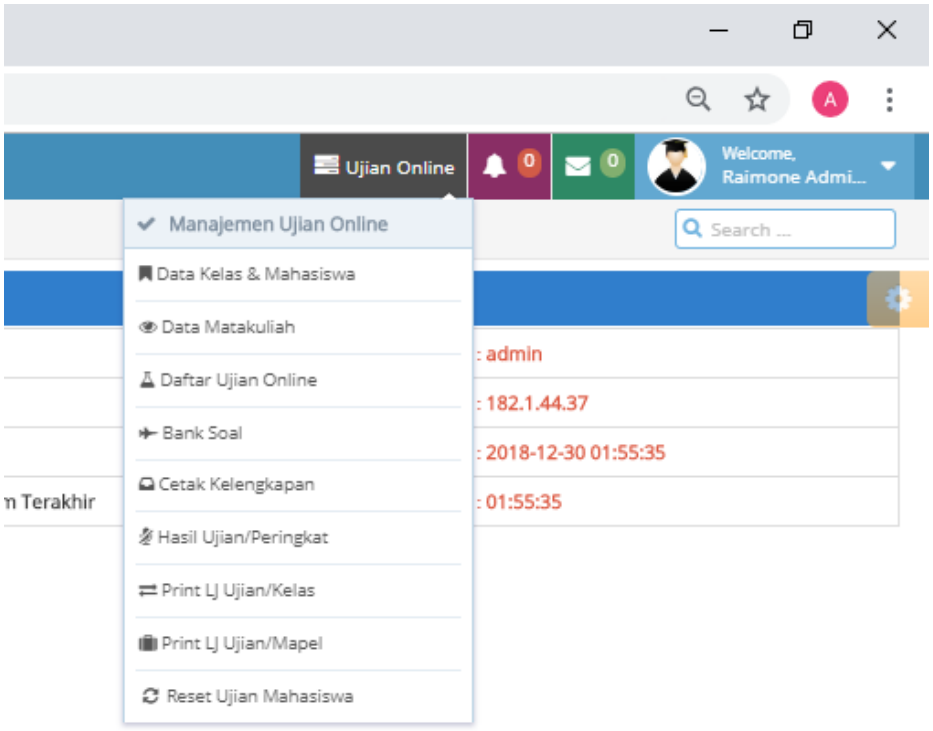

Figure 7. CBT management

Table 1. Online Exam Management Functions

Function	Menu
Class Data & Student	Class Data Entry and Students who will take the exam
Course Data Course	Data Entry
Online Exam List	View and make arrangements related to the Online exam
Question banks	A collection of subject matters for several subjects
Print Completeness	Printing Completeness of the Exam
Exam Results	Ranking Print Exam Results and can see exam ranks
Print LJ Exams/classes	Classes Print Class exams
Print LJ Exams/course	Print exams per Subject
Student Examination	Resest Returns to the Initial Exam Setting

3.4 Implementation of CBT

The web-based Online Exam (CBT) menu was developed to minimize cheating or leakage of questions that often occur during exams, prevent question limitations, damage to questions so that results are not released after being examined. The CBT system will also reduce implementation costs because, of course, there is no need to print questions and answer sheets with paper. Also, the exam with the CBT system is more practical, easier, and makes the examinees more focused. There is a time feature on the screen like Figure 8 so that it can maximize the time available. The more effective in working on problems, of course, more questions can be answered, so the possibility of graduation is also greater.

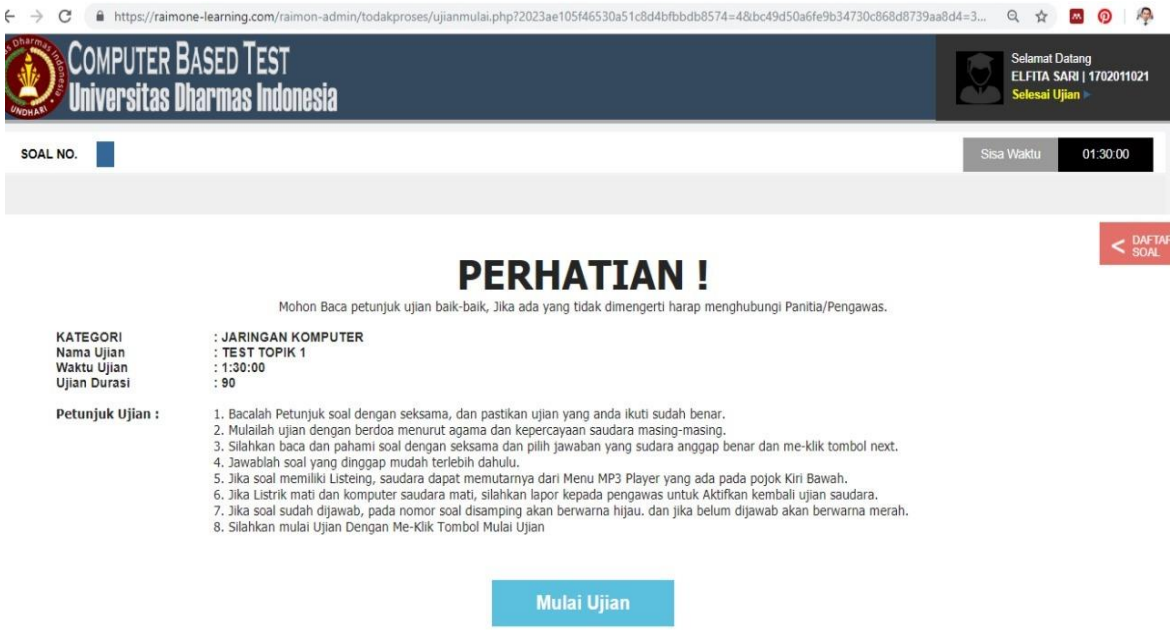

Figure 8. page view of starting the online exam

In the question menu display, there is a facility to answer questions that are considered easy in advance, and students can temporarily save their answers by clicking the “doubt” button. To do the next problem, please click the “next” button, if you want to work on the questions that are skipped then you can click the “previous” button

3.5 Survey of CBT implementation

After the application trial is carried out, the questionnaire is filled out by participants to gather information about the participants’ enthusiasm about the existence of the system and the level of software quality. The number of questionnaires successfully collected for 45 examinees. The results of the questionnaire processing are displayed in figure 9.

Figure 9. the results of the CBT implementation questionnaire

4. Conclusion

The creation of an online examination system is an online testing tool for optimizing exam activities. The online exam system provides benefits, including not needing to duplicate test papers and saving time for examination corrections.

The making of a Computer Based Test is an online testing tool for optimizing exam activities. The Computer Base Test system provides the benefit of not needing to duplicate test papers and saving time for examination corrections. The random function of the questions on the online examination system can reduce the cheating committed by examinees because the questions presented vary so that the examinees will receive different questions from one another.

Examination, mainly based on the Computer Based Test, can be done with this information system. It is necessary to adjust and socialize the application of this Computer Base Test information system. Cooperation between the stakeholders in the University is carried out to support the implementation of the information system that has been developed. For the next development so that the information system that is designed to provide maximum results and features.

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