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Design and Development of Online Learning Application Web Based Using Rapid Application Development Method: A Case Study of SMK Bintang Nusantara

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Abstract*:* E-Learning system which is an Information and Communication Technology in the field of education is needed as a system to make it easier for students and female students to access learning materials at school. At the Bintang Nusantara Vocational School, there is no Information and Communication Technology for students to access information about activities, as well as online learning. The development of the e-learning system uses the Rapid Application Development (RAD) development method. The RAD development method is an iterative and iterative fast development method until the final version is reached. Development using the RAD method takes 2 - 3 months and has 4 stages, namely planning needs by conducting interviews to determine the needs of the system being created, user design for making designs for making mockups, and also flowcharts, construction for carrying out system development by incorporating fisher- yates algorithm for the process of scrambling questions on the e-learning system that is created, and the last one is testing and evaluation using the USE Questionnaire method for evaluation testing. The test results using the USE questionnaire show an overall percentage of 89.2% with a very good predicate. Based on the test results, it can be concluded that the design of the website-based e-learning system is well received by users of the e-learning system at SMK Bintang Nusantara.

Keywords: *E-Learning, Fisher Yates, Rapid Application Development, USE Questionnaire.*

1. Introduction

In the field of education, Information and Communication Technology are needed to make it easier for students to access information at schools/universities. One example is the Bintang Nusantara Vocational School, which until now does not yet have Information and Communication Technology to make it easier for students to access information about activities, as well as online learning. One of the Information and Communication technologies which certainly makes it easier for students in terms of education is E-Learning or Electronic Learning.

E-Learning is a learning process that is carried out by the teacher and with students without requiring face-to-face meetings with one another [1]. E-learning is also a website-based communication platform that students can use without place and time restrictions to access learning tools such as assessments, document access, and so on [2]. With adequate technology for access to information, distance learning is becoming popular because it allows students to learn new skills without having to face-to-face with a physical mentor to teach them. E-learning was developed for the need to solve practical problems related to access and quality of learning experience [3].

Research that was carried out by Hilmi Fuad, Zainul Hakim, and Pramana Anwas Panchadria in 2013 by conducting Web-Based E-Learning Information System Design at SMK Negeri 1 Tangerang had several conclusions, E-learning makes it easier for students to obtain learning references. Because a material page is provided for viewing and downloading documents according to the subjects uploaded by the subject teacher. So that students are motivated to learn independently and also E-learning is designed to assist and become a means of carrying out the learning process [4]. Then there is a research that has been conducted by Siti Anisah with the title "Implementation of the Rapid Application Development Method in the Development of Goods Inventory Applications" concluding that Rapid Application Development is very helpful efficiently in a shorter time than the phases contained in the method, and the design uses the Rapid method. Application Development makes data processing more concise and provides convenience in designing a system [5]. Then another research was previously carried out by Antony Susanto and Henky Honggo in 2013 by designing an online exam at STMIK GI MDP based on a website implementing the fisher-yates algorithm which functions to randomize questions and the Levenshtein distance algorithm to compare answers when correcting questions. The study concluded that the use of the Levenshtein distance algorithm can help reduce student typos in typing answers to short answer question formats and also concludes that randomization of questions using the Fisher-Yates algorithm can make students get different multiple choice questions.

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Based on existing problems and previous research, a system is needed that is an online learning tool for Bintang Nusantara Vocational High School students to be able to access learning resources anytime and anywhere using the internet. The use of the Fisher-yates algorithm will also be developed in making this e-learning system to randomize the quiz questions given by the teacher. The design and construction of the e-learning application for Bintang Nusantara Vocational School will also use the rapid application development method. Rapid Application Development (RAD) is a set of methods developed to overcome the weaknesses of traditional systems development methods, such as the waterfall model [6]. The Rapid Application Development method is an alternative to the waterfall development model which was first introduced in 1991. By using the Rapid Application Development method, designers and developers can take advantage of user feedback obtained during the development process, to refine and improve designs or change software directions [7].

2. Literature

2.1. Rapid Application Development

Rapid Application Development (RAD) is a type of incremental software development that is based on a series of short iterative development cycles. The RAD model is considered a faster model compared to the waterfall. The RAD model is used for projects with a clear and understood structure. The Rapid Application Development Model is a rapid and iterative development methodology in which product owner feedback is a necessary element, prior to releasing the final version. Development using Rapid Application Development takes 2 - 3 months. At each iteration, the developer can validate the completed requirements and work on the suggested tasks [7]. There are stages of the rapid application development development model, namely requirement planning, user design, construction, and cutover [8].

2.2. Fisher-Yates Algorithm

The Fisher-Yates algorithm is taken from the names of Ronal Fisher and Frank Yates and is known as the Knuth Suffle which is taken from the name Donald Knuth. The Fisher-Yates algorithm is an algorithm that generates a random permutation of a limited data set, or it can be interpreted to randomize a set. The results of the Fisher-Yates algorithm will not be one-sided so that permutations will still have the same possibilities if implemented correctly [9]. The use of the Fisher-Yates algorithm in this system is to randomize quiz questions so that each student does not display the same order of questions.

2.3. USE Questionnaire

The Usefulness, Satisfaction, and Ease of Use or USE Questionnaire is a questionnaire package proposed by Lund to be used as a usability measurement and includes three measurement standards based on ISO 9241, namely efficiency, effectiveness, and satisfaction [10]. The use of the USE Questionnaire has 30 questions which are presented and grouped into four dimensions, namely usefulness, ease of use, ease of learning, and satisfaction [11].

2.4. Skala Likert

The Likert scale is a scale used to measure a person's perceptions, opinions, and attitudes [12]. The use of a Likert scale is using a variable which is an indicator for measuring questions and statements.

Table 1 Skala likert

No	Criteria	Score
1	Strongly Agree	5
2	Agree	4
3	Neither Agree nor Disagree	3
4	Disagree	2
5	Strongly Disagree	1

In the Likert scale, there is a calculation to find the total score by multiplying each score from each category by the total number of respondents who chose that category. The calculation looks for the total score, namely (1 * Strongly Agree) + (2 * Disagree) + (3 * Neither Agree nor Disagree) + (4 * Agree) + (5 * Strongly Agree) with information that can be seen in the skala likert in table 1.

Table 2 Interval category skala likert

Index	Category
0% - 19,99%	Very Bad
20% - 39,99%	Bad
40% - 59,99%	Poor
60% - 79,99%	Good
80% - 100%	Very good

Then, there is a calculation to find the maximum score obtained by multiplying the number of respondents, the maximum likert score, and also the number of questions asked to respondents. Finding the maximum score can be done by calculating the (Number of Respondents * Max Likert Score * Number of Questions). The Likert scale also has calculations to find the index value or percentage obtained from the total score and also the maximum score, then multiplied by 100. The search for index values can be done by calculating (TotalScore / MaxScore) * 100%. There

is a specified rating interval as shown in table 2.

3. Methodology

There is a stage that is carried out in the processing and preparation of research carried out using the rapid application development method with the aim of speeding up development time and ensuring that the application made meets user needs. There are four phases used in the rapid application development method, namely requirements planning, design, implementation, and cutover.

3.1. Requirement Planning

At this stage of requirements planning, it will identify user needs, development schedules, and also the functionality of the website-based e-learning application that will be created. At this stage, it produces Business Requirements Documents which contain the features that have been discussed based on the results of the interviews that have been conducted.

3.2. User Design

At this stage, the application design will be carried out based on the needs planning that has been done. The design is done by making a flowchart, a use case, and also making a user interface design for the website-based e-learning application that will be made. The design is made to determine the application workflow. At this stage, the iteration of the system is carried out until the user agrees that the system created is in accordance with the user's needs and can be used.

1. Use Case

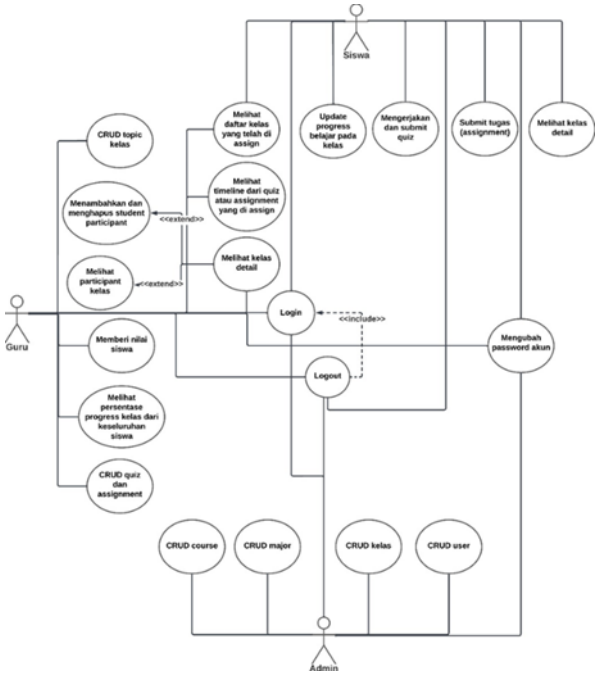

Fig 1. *Use case diagram*

Based on the *fig 1*, there are 3 roles in the system that will be created, namely teacher, student, and admin. To be able to access the main page of each role requires a login first. Teachers have access to create, update, delete, and view information from class topics, quizzes, and assignments. Teachers can also give grades, add or remove students from classes, and also see the percentage of students' overall learning progress in a class. Then students have access to take quizzes, update learning progress in class, and also submit assignments. Then the admin has access to create, update, delete, and view information from courses or subjects, majors, classes, and also users. Students, teachers, and admins can update information from accounts used such as passwords, and others.

2. Mockup

The \ref{mockup_login} image shows a mockup for the login page. There are 2 inputs that need to be filled in by the user when they want to log in, namely email and password which is then followed by pressing the login button. Then there is also the logo of the SMK Bintang Nusantara School.

Fig 2. *Mockup home student*

The *fig 2*, shows a mockup for the student home page. This page displays a list of class data, the progress of student learning percentages, and also a timeline to see the deadline for submitting or completing assignments.

Fig 3. *Mockup quiz student*

The *fig 3* shows a mockup for a student quiz page. This page displays the details of the quiz data provided by the teacher. There is a display for information from quizzes such as quiz title, deadline, duration, grade if students have finished

taking quizzes, and others.

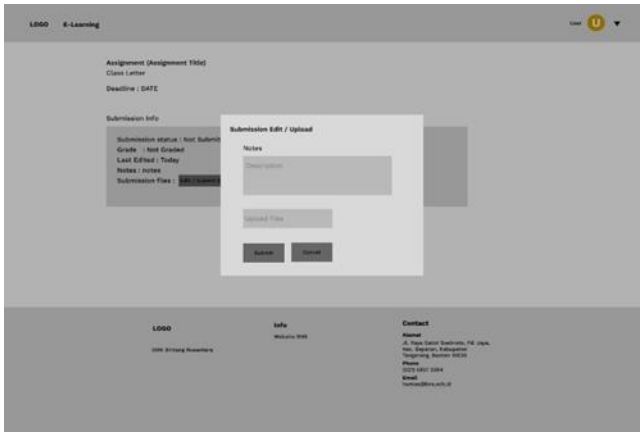

Fig 4. *Mockup upload student*

The *fig 4*, shows a mockup for a student assignment details page with a pop up to upload or update assignment submissions. The pop up displays input notes, a button to upload files, a submit button, and cancel to close the pop up.

3.3. Construction

After user design is successfully made, the construction phase will be carried out. At this stage, the coding of the website-based e-learning application will be carried out. Coding is done based on the user interface that has been made at the design stage. This stage involves both front-end and back-end development. Front-end coding is made using the Javascript programming language using the ReactJS framework and also Tailwind CSS for display customization. Then for the back-end coding, it is made using the Javascript language with the ExpressJS framework, NodeJS, and also MongoDB for the database system. Back-end and front-end coding produces an E-learning site for student learning at Bintang Nusantara Vocational School.

3.4. Cutover

At this stage changes are made to the old system with the new one, including by carrying out tests, and so on after carrying out the construction phase. This stage is carried out to ensure that the design is running well.

4. Result and Discussion

The development method used in the development of this e-learning website system is Rapid Application Development (RAD). There are development results after the user design stage is carried out, which can be seen in *Fig 5* which is the result of the implementation on the login page display based on the mockup design that has been made. This page displays 2 inputs that need to be filled by the user when they want to log in, namely email and password. Users can log in by pressing the login button which will redirect to the main page if the login is successful.

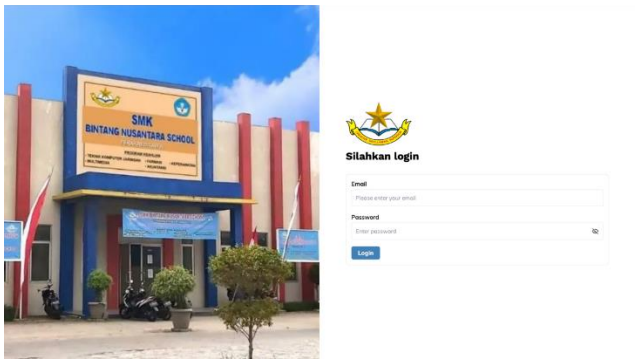

Fig 5. Login page

The *fig 6* is the result of implementation on the home page display for students based on the mockup design that has been made. This page displays a list of class data and a timeline or information on the deadline for completing assignments or quizzes. This page also allows students to switch to the class detail page by clicking on the desired class data.

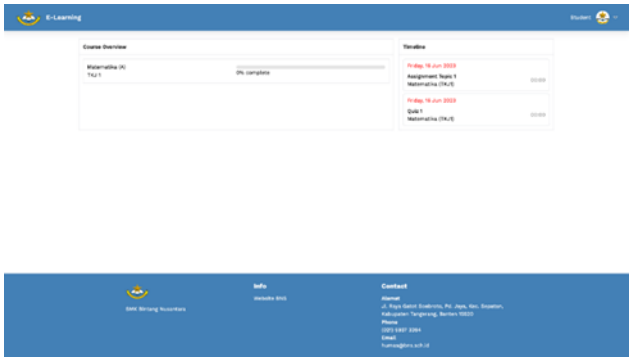

Fig 6. Quiz page student

The *fig 7* is the result of implementation on the quiz page display for students based on the mockup design that has been made. This page displays information about quiz details, and quiz questions that students can work on if the time and duration are still valid, when the time and duration are invalid or students have submitted quizzes, this page becomes a student quiz review page and displays the grades of the quizzes that have been done.

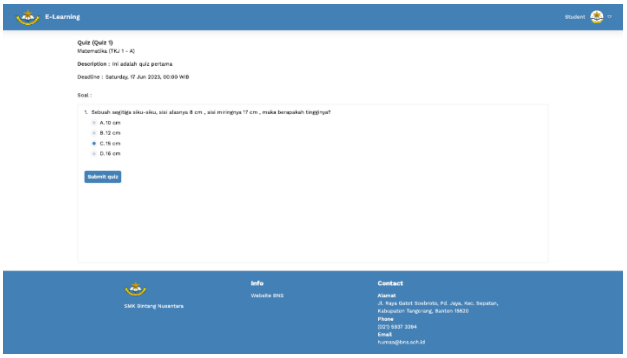

Fig 7. Upload page student

The *fig 8* is the result of implementation on the assignment detail page display for students by displaying an edit or upload assignment modal based on the mockup

design that has been made. The modal displays a record input for updating student assignment submission records, as well as a select files button for adding assignment submission files. The modal shown allows students to delete files that have been uploaded by clicking the delete icon on the desired file. Then there is also an update button to update, and a cancel button to close the modal.

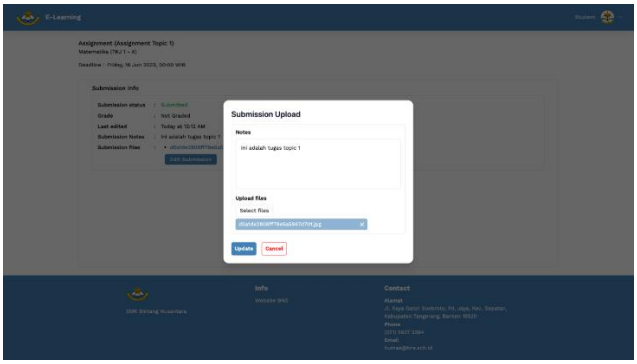

Fig 8. Assignment detail page

Then in *fig 9* is a code snippet for applying the fisher-yates' algorithm to randomize the order of student quiz questions. The application of the Fisher-yates' algorithm is carried out according to the stages described on a theoretical basis. It can be seen that the variable *I* is used to hold the amount of data from the array sent to the *fisheryatesrandomdata* function. Then it is repeated as many times as the number of data and the required condition is that if the random data result is the same as the amount of data, then it is not skipped, but if the results are different, then data exchange is carried out from the random data index to the I data index or the amount of data. The *fisheryatesrandomdata* function will return an array of data that has been randomized using the fisher-yates' algorithm.

```
export const fisherYatesRandomData = (arrayData = []) => {
  let i = arrayData.length
  while (i--) {
    const j = Math.floor(Math.random() * i)

    if (i !== j) {
      const temp = arrayData[j]
      arrayData[j] = arrayData[i]
      arrayData[i] = temp
    }
  }

  return arrayData
}
```

Fig 9. Fisher yates code

5. Testing and Evaluation

The testing and evaluation phase is carried out as the last stage after implementation. Evaluation was carried out by distributing questionnaires containing 30 questions asked to respondents with a scale ranging from strongly disagree to strongly agree. The list of questions asked to respondents was divided into four aspects based on the USE Questionnaire method, namely usefulness, ease of use, ease of learning, and satisfaction.

5.1. Usefulness

There are eight questions given to respondents based on the usefulness aspect which can be seen in the table 3.

Table 3 Usefulness aspect

Question number	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
1	0	0	0	18	16
2	0	0	0	13	21
3	0	0	0	9	25
4	0	0	1	14	19
5	0	0	1	15	18
6	0	0	1	16	17
7	0	0	1	18	15
8	0	0	1	18	15
Total	**0**	**0**	**5**	**121**	**146**

Based on the summary results table that can be seen in table 3, there is a calculation that is carried out to get the results of the usefulness value by calculating the total usefulness score using the calculation of the total usefulness score = (0 * 1) + (0 * 2) + (5 * 3) + (121 * 4) + (146 * 5) = 1229. Then a calculation is performed to calculate the maximum total score of usefulness = 34 * 5 * 8 = 1360. After getting the total score and maximum score on usefulness value, it is necessary to do a calculation to find out the percentage of the usefulness value which can be seen in the calculation of Usefulness Value = (1229 / 1360) * 100 = **90.3%.**

5.2. Ease of Use

There are eleven questions given to respondents based on the ease of use aspect which can be seen in the *table 4*.

Table 1 Ease of Use aspect

Question number	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
1	0	0	0	11	23
2	0	0	1	16	17
3	0	0	0	13	21
4	0	0	1	10	23

5	0	0	2	13	19
6	0	0	1	11	22
7	0	0	3	12	19
8	0	0	3	11	20
9	0	1	1	13	19
10	0	1	2	14	17
11	0	0	1	16	17
Total	**0**	**2**	**15**	**140**	**217**

Based on the summary results table that can be seen in *table 4*, there is a calculation that is performed to obtain the results of the ease of use score by calculating the total ease of use score using the total ease of use score calculation = (0 * 1) + (2 * 2) + (15 * 3) + (140 * 4) + (217 * 5) = 1694. Then calculations are performed to calculate the maximum total score from the value of ease of use = 34 * 5 * 11 = 1870. After getting the total score and maximum score on the ease of use value, it is necessary to do a calculation to find out the percentage of the ease of use value which can be seen in the calculation of Usefulness Value = (1694 / 1870) * 100% = **90.5%.**

5.3. Ease of Learning

There are four questions posed to respondents based on the ease of learning aspect which can be seen in the *table 5*.

Table 2 Ease of learning aspect

Question number	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
1	0	0	1	17	16
2	0	0	1	20	13
3	0	0	0	12	22
4	0	1	3	15	15
Total	**0**	**1**	**5**	**64**	**66**

Based on the summary results table that can be seen in the *table 5*, there is a calculation that is performed to get the results of the ease of learning score by calculating the total ease of learning score using the total ease of learning score calculation = (0 * 1) + (1 * 2) + (5 * 3) + (64 * 4) + (66 * 5) = 603. Then calculations are carried out to calculate the maximum total score from the value of ease of learning = 34 * 5 * 4 = 680. After getting the total score and maximum score on the ease of learning value, it is necessary to do a calculation to find out the percentage of the ease of learning value which can be seen in the calculation of Usability Value = (603 / 680) * 100% = **88.6%.**

5.4. Satisfaction

In the aspect of satisfaction (satisfaction), there are seven questions posed to respondents based on what can be seen in the *table 6*.

Table 3 Satisfaction aspect

Question number	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
1	0	0	1	15	18
2	0	4	4	15	11
3	0	0	2	15	17
4	0	1	3	14	17
5	0	0	3	15	16
6	0	4	1	12	17
7	0	0	3	21	13
Total	**0**	**8**	**17**	**107**	**109**

Based on the summary results table which can be seen in the *table 6*, there is a calculation that is performed to obtain the results of the satisfaction value (satisfaction) by calculating the total satisfaction score using the calculation of the total satisfaction score = (0 * 1) + (8 * 2) + (17 * 3) + (107 * 4) + (109 * 5) = 1040. Then do the calculations to calculate the maximum total score from the value of satisfaction (satisfaction) = 34 * 5 * 7 = 1190. After getting the total score and maximum score on the value of satisfaction, it is necessary to do a calculation to find out the percentage of the value of satisfaction (satisfaction) which can be seen in the calculation Usability Value = (1040 / 1190) * 100% = **87.3%.**

5.5. Total Aspects

The overall score is the average value of the four aspects that have been obtained, namely the usability aspect, the convenience aspect, the ease of learning aspect, and the satisfaction aspect. The overall value can be obtained as in the following calculation: *Total* = ((90.3% + 90.5% + 88.6% + 87.3%) / 4) * 100% = **89.2%.**

6. Conclusion

There is a conclusion based on research results from the development method and also an evaluation of the e-learning website design that has been carried out, several conclusions are obtained, namely the website-based e-learning design was successfully designed and built using the Rapid Application Development development method, the e-design development stage -web-based learning is

carried out with a processing time of 3 months. Work is carried out based on user needs and following the stages of the rapid application development method. Then the implementation of the Fisher-Yates Algorithm was successfully implemented in this website-based e-learning system for Bintang Nusantara Vocational School. Testing and evaluation is carried out by distributing questionnaires using the USE Questionnaire method which consists of 4 aspects, namely usefulness, ease of use, ease of learning, and satisfaction. The results of the questionnaire obtained 34 respondents from the results of distributing the questionnaires to users of the e-learning system at SMK Bintang Nusantara. Based on the results of the questionnaire which was filled in by 34 users of the e-learning system, it can be concluded that the users strongly agree with the website-based e-learning system that has been created. This is evidenced by the percentage between sections, namely 90.3% for usefulness, 90.5% for ease of use, 88.6% for ease of learning, and 87.3% satisfaction.

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Conflicts of interest

The authors declare no conflicts of interest.

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