Developing and Analyzing the Quality of Games Based On Capture the Flag "Jeopardy Using Learning Method of Quiz Team

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Abstract. This research aimed to: (1) develop educational games based on capture the flag "jeopardy" and learning method of quiz team, and (2) determine the quality of the developed educational games by ISO/IEC 25010 standard. This research was research and development (R&D). It used Waterfall of development by Pressman. These model consisted of communication, planning, design, construction, and deployment. The results of this research were as follows. (1) It produced a game based on capture the flag "jeopardy" by using learning method of quiz team based on the web that was developed by Waterfall. It had the main feature to evaluate participants learning in individual, team and it had exercise as training materials. (2) The test results showed that the developed educational game application met the ISO/IEC 25010 standards on functional suitability, performance efficiency, usability, security, reliability, maintainability, and portability aspects.

1. Introduction

The development and progress of the technology can be categorized as extraordinary. This had the effect of good and bad. One good effect is that information can be accessed anywhere without any space and time constraints, but this has a negative impact on some service providers, in the form of online transaction services. The bad impact was due to network security vulnerabilities in providing services, so that irresponsible parties took advantage of this. Even big losses are experienced if this is not handled properly.

Many cases had occurred in network security at International and National, one of which happened in Indonesia in the collapse of lazada e-commerce accounts. According to [1], there are several e-commerce transactions through credit cards that don't use additional authentication through telephone numbers. Cross site scripting, and phishing mode with inject scripts on the official web is also possible for the perpetrators, so that users don't realize identity theft of usernames and passwords.

Events experienced by lazada need to getting serious attention of the manager. Technique for securing information using encryption. The technique uses algorithms that are taught in network security courses.

Network security is a lesson considered difficult by students, it is because of the many be mastered algorithms, logic, and programming languages, because to make a network security algorithm must

have logic and the appropriate programming language. The limitations of the media and the use of conventional learning methods is one of the obstacles in the learning process of network security. Learning is done with a presentation session and continued question and answer, this results in less active learning so the quality of network security learning is still low.

Individual potential is obtained from the teaching and learning process that uses elements of teaching media, because through the media students can be motivated and receive stimuli that can affect the psychology of students. According to [2], suggesting that students will easily understand what is taught by using the help of learning media. Effective learning processes and delivery of messages during learning can be helped by the teaching media.

According to [3], it was suggested that lectures traditionally, where lecturers teach in front of the class, only made students absorb the material taught by 5%. By reading it yourself, students are able to absorb 10% material. By looking at audio-visual for example, through the film implementation of management systems in the field, 20%. Students see demonstrations, using of tools, or using simulation methods to absorb 30%. Students discussing in intense groups will make them absorb 50%. Students do their own practice in the field or laboratory to absorb 75%, and the highest is a system where students can teach each other another friend by 90%.

Based on the above research, to improve the quality of learning from students, active learning is needed. Active learning in question is steps or plans that invite students to learn actively in each learning by using the brain / mind, both to find the main ideas of the subject matter, solve problems or apply what they have just learned into a problem that exist in real life.

In supporting the network security teaching and learning process, by conducting active learning in network security courses using educational games by collaborating the quiz learning methods of the team. One interesting learning media to be used as an alternative to network security is Capture the Flag (CTF). CTF is a special competition of network security, there are three game categories from CTF: Jeopardy, Attack-Defence, and Mixed.

According to [4], states that "The type of quiz team can turn on the atmosphere and enable students to ask or answer". This type of quiz team begins with explaining the subject matter in a classical manner, then students are divided into large groups. All group members together study the material through worksheets. They discuss the material, give each other directions, and give each other questions and answers to understand the material. After completion of the material an academic match is held. This research develops a learning media application, in the form of games which in this case take games that are often used for network security competition, then collaborate on the game using the quiz team method. The final results of this application are expected to be useful for teachers to make classes active in learning, and for students to be more active in learning. As well as supporting the government to carry out the screening of 10,000 Indonesian cyber security gladiator candidates, as stated in the press release of the Ministry of Communication and Information Technology No. 12/hm/Kominfo/01/2017 concerning "Born To Control". That the Born To Control Program is felt to be very important to be held so that technological inequality does not occur so far with existing HR (Human Resource). This is also felt important so that the government should no longer import or bring in foreign experts to deal with cyber security issues in the country of Indonesia.

Of course to do software development should be tested before being distributed to users. According to [5], states that testing on software is needed to reduce the risk of problems before the software release. This study uses the ISO / IEC 25010 standard, because it includes international standards. ISO / IEC 25010 has eight characteristics in software quality testing, namely, functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability.

2. Research Methods
This study aims to support learning by developing educational games using the quiz team learning method. The development model used in this research is waterfall.

3. Procedure
The development procedure is carried out using the Waterfall model. The procedure is carried out in five stages, namely (1) communication; (2) planning; (3) modeling; (4) construction; and (5) deployment. Whereas for the quality testing of software applications using the ISO / IEC 25010 standard consisting of aspects (1) functional suitability, (2) performance efficiency, (3) usability, (4) security, (6) reliability, (7) compatibility, (8) maintainability, and (9) portability.

3.1 Communication
Based on the observations concluded for functional requirements analysis in the Application "Educational game based on capture the flag jeopardy using the quiz team learning method in network security courses" based on ISO / IEC 25010 as follows: (1) educational game applications can be used at any time, anywhere and can accessed by each registered user. (2) the initial display of the educational game application in the form of a login page so that only registered users can use the application. (3) users who can access the educational game application are divided into 2 parts, namely lecturers, and students.

3.2 Planning
Planning the scheduling of the software development process is carried out with the aim that this research runs in accordance with a predetermined time. Scheduling in this research is done by adjusting the learning time of network security courses.

3.3 Modelling
The stages carried out after needs analysis are stages of modeling (design), which at this stage include the design of UML (Unified Modeling Language), database design and system interface design. UML that was successfully created at the design stage consists of several types, including use case diagrams, activity diagrams, class diagrams and sequence diagrams. The design of the use case diagram is shown in Figure 1.
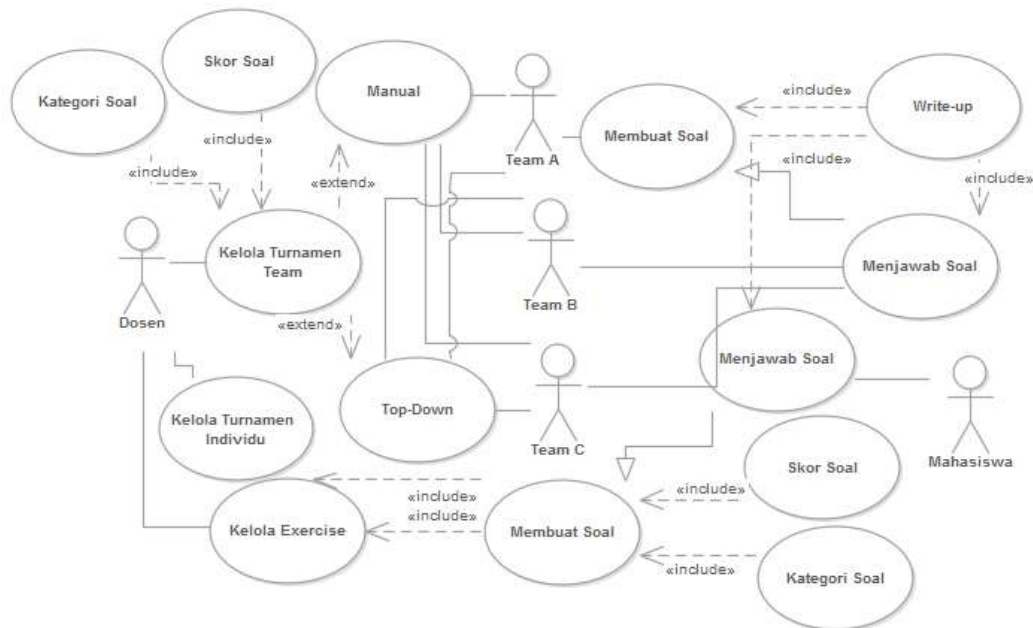
Based on Figure 1, the lecturer/admin actor can manage individual and team tournaments, and manage the exercise for training facilities. Individual tournaments are managed by the lecturer by making questions according to the question category and determining the value of the question, the questions made will be answered by each registered student. Team tournaments are managed by lecturers by dividing students into 3 major groups and determining the value of the questions.

The division of teams can be done manually by the teacher by looking at the abilities of any participant that can be made into a team. In addition to manual team division, team division can also be done automatically by the application by looking at each individual score, individual scores will be sorted from highest to lowest and evenly divided by top-down distribution, if the number of participants 12 teams A will get participants with individual scores (1, 12, 4, 9), team B will get participants with individual scores (2, 11, 5, 8), and team C will get participants with individual scores (3, 10, 6, 7).

The team selected as the question giver has the right to make a question accompanied by reporting the answer to the question according to the instructions of the lecturer, and the team chosen as the answerer, has the right to answer questions along with reporting the answer to the question. Each participant was given a training tool through the exercise feature to increase ability in problem solving.

3.4 Construction
Database on this educational game application uses Mysql. Tables that have been previously designed using MySQL Workbench tools are configured so that the database can help developers determine inter-table relations in the database. The database table that has been configured at this stage is 20 tables according to the previous database design. The database management process is done using the PHPMyAdmin application.

The process of developing educational game applications uses an atomic code editor 1.17.7 and Laravel 5.2 framework for coding. The Laravel 5.2 Framework uses the Model-View-Controller (MVC) pattern which has 3 components, namely Model, View and Controller. The model has a function regarding data storage from the application, View has a function to display data, while the Controller has a function to process the data obtained by the Model and give it to View to be displayed.

The interface implementation phase is based on the mock ups that have been made before. The educational game application interface display consists of 13 page designs, which consist of pages for lecturers and students. The results of the mock up implementation are in the form of an interface that will later be used in educational game applications.

After the application development stage is carried out, the next step is to carry out the application testing stages with the application quality standards ISO / IEC 25010 which includes the aspects of functional magic, performance efficiency, usability, security, reliability, compatibility, maintainability, and portability.

3.5 Reliability
Reliability testing uses the PHPUnit tool to analyze code coverage from the application source code. The code coverage analysis results from the application source code are 65.07%. These results are then calculated using the formula from TIOBE Quality Indicator, the reliability testing calculation is as follows:

$$Score = min(0.75 \times 65.07 + 32.5, 100) = 81.30\%$$

The score for the calculation results is 81.30%. Reliability test results are stated Good and meet reliability aspects.

3.6 Maintainability
Maintainability testing uses the PHP Copy / Paste Detector tool to analyze code duplication from the application source code. The result of duplication code analysis from the application source code is 0.19%. These results are then calculated using the TIOBE Quality Indicator formula, maintainability testing calculation as follows:

$$Score_d = min(-30 \times \log 10 (0.19) + 60, 100) = 81.64\%$$

The score calculated is 81.64%. Maintainability test results are stated Good and meet maintainability aspects.

3.7 Performance Efficiency
Performance efficiency testing uses a tool from GTMetrix. The performance efficiency test results are as follows :

Table 1. Test Results for Performance Efficiency

No.	Web Pages	Fully Loaded Time (s)	Total Page Size (KB)	PageSpeed Score	YSlow Score
1.	*Login*	2.7	182	A(99%)	A(96%)
2.	*Data Play*	2.4	185	A(99%)	A(95%)
3.	*Data Play Individu*	2.3	185	A(99%)	A(95%)
4.	*Data Play Team*	2.4	184	A(99%)	A(95%)
5.	*Data Play Score*	2.4	185	A(99%)	A(95%)
6.	*Data Play Description*	2.3	185	A(99%)	A(95%)
7.	*Data Play Exercise*	2.6	185	A(99%)	A(95%)
8.	*Data Grid Rule*	2.3	185	A(99%)	A(95%)
9.	*Data Grid*	2.3	185	A(99%)	A(95%)

No.	Web Pages	Fully Loaded Time (s)	Total Page Size (KB)	PageSpeed Score	YSlow Score
10.	Notification Data Register Account Data	2.2	184	A(99%)	A(95%)
11.	Register Course Data	2.3	184	A(99%)	A(95%)
12.	Register Category Data	2.6	184	A(99%)	A(95%)
13.	Register Time	2.7	184	A(99%)	A(95%)
	Rata-rata	2.42	184.38	A(99%)	A(95.08%)

3.8 Compatibility
Compatibility testing uses a variety of operating systems with different screen resolutions both desktop and mobile. Desktop version compatibility testing is done using 3 different operating systems and different resolutions. Judging from the tests carried out the application can be operated properly.

3.9 Portability
Portability testing uses cross browsing compatibility testing, which is to run applications on different browsers both desktop and mobile. Based on testing that has been done, that the application can be operated properly 7 web browsers on the desktop.

3.10 Security
Security testing using the Acunetix Web Vulnerability Scanner 9.5 application. the results of the test are as follows:
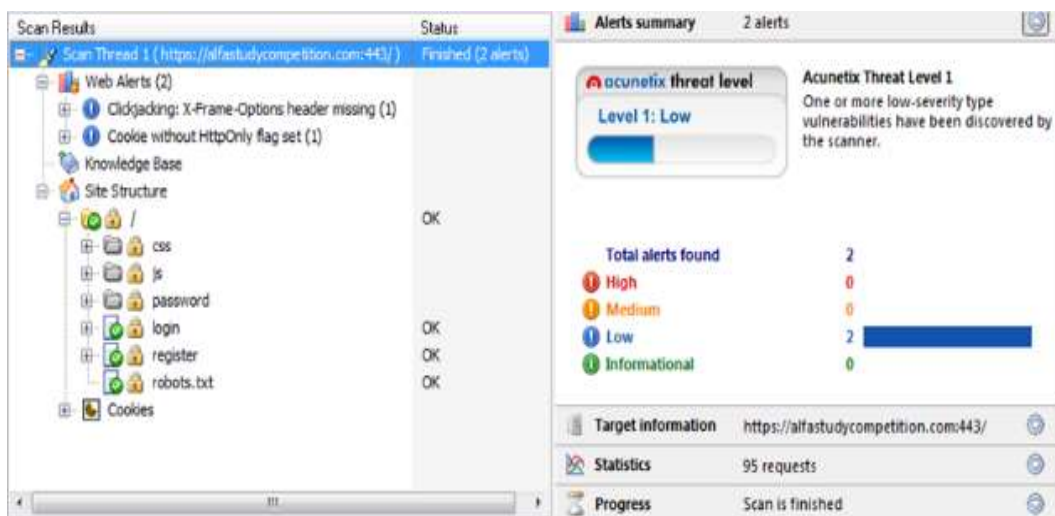

Figure 2. Test Results for Security

Based on the results of security testing, it can be concluded that the application has a level 1 security level. Security with level 1 indicates the data flow encryption is still lacking in the server directory [6]. 2017)

3.11 Functional Suitability
Functional suitability testing is tested on 2 people who are experts in web development. The instruments tested fulfill sub-characteristics of functional completeness, functional appropriateness, and functional correctness. Based on the results of software quality testing conclusions obtained from sub-characteristic calculations functional completeness, functional appropriateness is X = 1 and the functional correctness is X = 1, in this test the software is said to be good in functional suitability if X values close to 1, it can be concluded that Educational game application has fulfilled the functional aspects of ISO / IEC 25010 suitability.

3.12 Usability
Usability testing using a USE Questionnaire questionnaire of 30 items was measured using a Likert scale. The USE Questionnaire questionnaire was given to 47 respondents. The test results are then calculated to determine the interpretation of usability aspects, these calculations are as follows:
$$\text{Score}_{full} = (651 \times 5) + (703 \times 4) + (55 \times 3) + (1 \times 2) + (0 \times 1) = 6234$$
$$P_{score} = 6234/7050 \times 100\% = 88.43\%$$

The results of the usability testing percentage is 88.43%, the usability test results are stated to be Very Eligible and meet the usability aspects.

4. Conclusion

The development resulted in an educational game application based on capture the flag "jeopardy" with the quiz team learning method for network security. The web-based application was developed with the waterfall software development model. The application has the main features for evaluating learning to individual participants, teams, and exercise as training material. Furthermore, the test results show that the application meets the ISO / IEC 25010 standards. Functional aspects of suitability, which runs 100% and has an X value = 1. Performance efficiency aspects, which can load web pages in 2.42 seconds, PageSpeed performance by 99% (grade A) and YSlow at 95.08% (grade A). Usability aspect, obtained Cronbach alpha value 0.892 with a percentage of 88.43%. Security aspects, with the level of vulnerability to attacks at level 1 (low). Compatibility aspects, applications can be operated in various desktop and mobile operating systems in various screen resolutions. The reliability aspect, with code coverage of 65.07%, resulted in an TIOBE Score of 81.30%. Maintainability aspects, which have duplication code results of 0.19% so TIOBE Score is 81.64%. Portability aspect, the result that there is no error when run on various desktop and mobile browsers that are tested.

5. References

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