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Designing an Online Examination System with Object Detection-based Proctoring

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Abstrak

Evaluasi memiliki peranan penting dalam proses pembelajaran, termasuk penggunaan ujian sebagai media evaluasi pembelajaran yang mengukur pemahaman siswa terhadap materi yang diajarkan. Upaya menjaga integritas evaluasi melibatkan langkah-langkah keamanan, seperti penerapan proctoring online dan pemanfaatan teknologi kecerdasan buatan. Penelitian ini bertujuan untuk mengembangkan sistem ujian online berbasis object detection, dengan tujuan meningkatkan efektivitas evaluasi dan mengatasi potensi kecurangan. Penelitian ini menggunakan metode penelitian Research and Development (R&D) dengan model pengembangan aplikasi yang digunakan adalah Rapid Application Development (RAD). Berbagai tahapan dilakukan dalam penelitian ini, mulai dari pengumpulan data melalui studi literatur, wawancara, dan observasi untuk mengumpulkan informasi yang relevan. Selanjutnya, masalah dirumuskan berdasarkan data yang telah terkumpul, dan dilanjutkan dengan pemodelan dan pengembangan aplikasi, termasuk analisis kebutuhan sistem, pemodelan proses aplikasi, database, dan user interface. Ujian aplikasi dilakukan dengan metode blackbox testing guna memastikan kualitas hasil akhir. Validasi ahli dilakukan untuk mengevaluasi kelayakan sistem ujian yang dihasilkan. Aplikasi kemudian diimplementasikan melalui ujian kepada siswa, diikuti oleh analisis data berdasarkan tanggapan pengguna dan penilaian guru. Temuan penelitian mengindikasikan bahwa sistem ujian online berbasis object detection secara postitif berpengaruh dalam meningkatkan efektivitas evaluasi pembelajaran, terutama dalam aspek obyektivitas yang mengalami peningkatan sebesar 73,1%. Penilaian melalui instrumen PSSUQ juga mengindikasikan hasil positif terhadap sistem ujian, dengan nilai pada masing-masing aspek berada di bawah batas maksimal sesuai aturan penilaian PSSUQ.

Kata Kunci: Sistem Ujian Online; Object Detection; Evaluasi Pembelajaran; Efektivitas Evaluasi;

Abstract

Evaluation plays a significant role in the learning process, including the use of exams as a means of assessing students' understanding of the material. Continuous evaluation processes assist teachers in understanding the strengths and limitations of their teaching methods. However, the importance of addressing academic dishonesty issues in evaluations is also emphasized. Upholding evaluation integrity involves security measures such as implementing online proctoring and utilizing artificial intelligence technologies. This research aims to develop an object detection-based online exam system to enhance evaluation effectiveness and mitigate potential cheating. The study employs the Research and Development (R&D) methodology and using the Rapid Application Development (RAD) model for application development. Various stages are undertaken in this research, starting with data collection through literature review, interviews, and observations to gather relevant information. Subsequently, the identified issues are formulated based on the collected data, followed by application modeling and development, including system requirement analysis, application process modeling, database design, and user interface development. Application testing is performed using black-box testing to ensure the quality of the outcome, and object detection is validated using accuracy and intersection over union metrics. Expert validation is conducted to evaluate the feasibility of the generated exam system. The application is then implemented through exams administered to students, followed by data analysis based on user feedback and teacher assessment. Research findings indicate that the object detection-based online exam system positively contributes to reducing academic dishonesty by 73.1%. Assessment using the PSSUQ instrument also shows positive results for the exam system, with scores for each aspect below the maximum threshold according to PSSUQ assessment criteria.

Keywords: Academic Dishonesty; Object Detection; Online Exam System; Proctor;

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1. INTRODUCTION

Learning is an activity carried out by every human being from birth, and learning is a planned process with certain goals that involve interrelated components. The success of learning activity can be influenced and determined by selection of proper teaching materials and media (Nicolaou, 2021). In the wake of COVID-19 pandemic, there has been an increase on online education, which described as education being delivered in online environment through the use of internet (Singh & Thurman, 2019).

Evaluation is an inseparable component of learning. In the learning process, evaluation is one of the stages that teachers must go through to assess the extent of student progress and development. Through evaluation, teachers can collect relevant information about students' understanding of the subject, the skills they have, and their ability to apply the concepts they have learned. The results of this evaluation can then be used as feedback for teachers to improve and perfect the learning programs and activities that have been designed. Thus, evaluation plays a role as an important tool in supporting improvement, developing the learning process, and understanding student achievement levels.

In the context of evaluation activities, especially through daily tests, the main aim is to measure the relevance of students' learning abilities to the goals or standards that have been set. Through this evaluation process, teachers can obtain the information needed to assess the extent to which students have achieved the set learning objectives. After knowing the student's level of understanding, the teacher can further assist the student in developing a deeper understanding of the material being studied. In the case of online learning, online exam become prominent part of learning activity (Karthika et al, 2019).

According to Shraim (2019), the use of an online examination system has significant benefits in terms of generating reliable scoring for test result and support deeper analysis. In this system, evaluation data can be generated automatically and stored in a structured form, making it easier for teachers to analyze and interpret evaluation results. This allows teachers to obtain more accurate information about student progress and make decisions that are based on more solid data. Apart from that, the online exam system also allows collection of real-time student progress data. With evaluation data collected in real-time, teachers can respond quickly and effectively in preparing appropriate learning plans to meet student needs.

In line with the widespread use of online exams, a lot of academic cheating has occurred. Academic dishonesty is an educational phenomenon that is often encountered in the world of education. Factors that influence the occurrence of academic cheating include pressure from families who want their children (students) to get high grades and good rankings, pressure from their own peers, faculty not punishing the cheaters, and even technological advances (Aplin et al, 2021), simply because grades are considered a measure of success. The many phenomena of plagiarism or other forms of academic cheating illustrate that an individual's behavior is not solely determined by the level of knowledge they have. It also had been observed that during online learning, student still lack sufficient self-regulation, which also contribute to academic dishonesty (Rasheed et al, 2020). Student’s overall quality does not improve through examination system alone (Chen & Zou, 2018).

The current online instruction platform still lacks the measures to prevent students from cheating (Jia & He, 2022). Protection of exam integrity and prevention of cheating are very important aspects. In this case, the implementation of security measures such as online proctoring (Hussein et al, 2020) or the use of artificial intelligence technology can help detect cheating and maintain the validity and reliability of exam results. Thus, it is important for educational institutions to implement appropriate security measures in using online-based examination systems. This is evident from the results of interviews with teachers at SMK Pasundan 1 Cimahi, where they stated that the online-based examination system has a very significant role in the school context, especially after the Covid-19 pandemic occurred throughout the world which encouraged students to learn online. on line. However, in using an online-based examination system, an evaluation mechanism is needed that can reduce the opportunity for cheating by students, so that the examination assessment process can take place fairly.

One way to develop the online proctoring system is by implementing object detection on the system. Object detection allows the system to locate the target of interest from the image and determine its category

(Deng et al, 2020). Object detection has been used in various fields such as image retrieval and surveillance (Zou et al, 2023), which can be used to detect whether the student cheat or not through their body language captured by the camera.

Based on the background explained above, the contribution made in this research is designing and developing an online examination system based on object detection as a learning evaluation medium to increase the effectiveness of evaluation. This research discusses how to design and develop an online exam system to reduce cheating committed by students in the learning evaluation process, how the use of an online exam system based on object detection has an impact on increasing the effectiveness of learning evaluation, and how teachers and students respond to the online exam system used. as a learning evaluation medium.

2. METHOD

This research method uses research and development methods with the Rapid Application Development (RAD) development model. The research design used is a modification of the research and development method which implements 6 steps out of 10 steps. The original research design by Borg and Gall (Gustiani, 2019) can be seen in Figure 1.

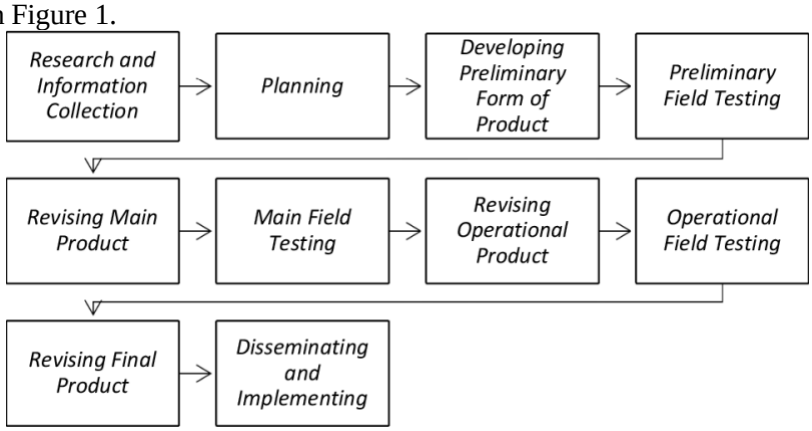

Figure 1. Research Design by Borg and Gall

2.1 Research and Information Collecting

At this step, the researcher collects data/information which is used to formulate the problem and the efforts made to overcome the problem. This stage uses several data collection techniques, namely, literature studies carried out by reviewing research on journals related to the use of online-based evaluation media in increasing the effectiveness of learning evaluation, how to develop a website-based online exam system, and how to develop proctoring system features and their use in the online exam system. Next, using interview techniques, interviews were conducted with teachers and principals at SMK Pasundan 1 Cimahi to find out what obstacles teachers faced when evaluating student learning through exam media. The final technique is observation, observation is carried out to directly observe the examination process and examination system used at SMK Pasundan 1 Cimahi.

2.2 Planning

At this step, the researcher formulated the problem based on the results obtained from the data collection stage. After the data is collected, researchers analyze and evaluate the information obtained to gain a deeper understanding. Based on this analysis, researchers can identify problems that occur at SMK Pasundan 1 Cimahi. In this research, the problem that was identified was that schools need an examination system that can reduce the problem of cheating committed by students when taking exams so that the learning evaluation process can be more effective and does not deviate from the principle of evaluation objectivity, and also requires an examination system that can be adapted if things happen that force the evaluation process to be carried out remotely. Based on this problem, the research object determined is to increase the effectiveness of evaluation on the use of the online examination system.

2.3 Develop Preliminary Form of Product

At this step, researchers carry out application design and development. This stage refers to the rapid application development model as an application development method. This method emphasizes on much faster development with higher quality end-product (Nalendra, 2021). An illustration of the rapid application development model can be seen in Figure 2.

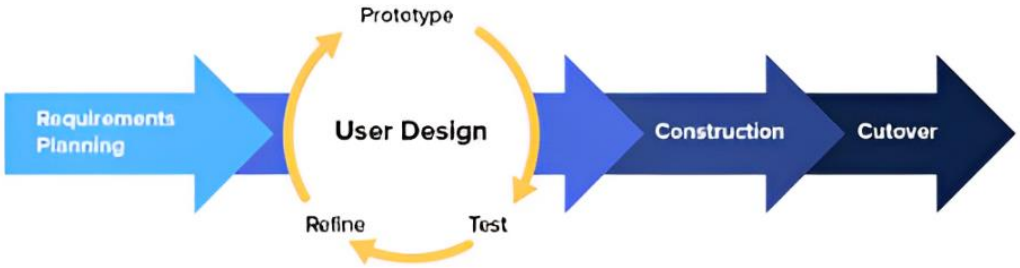

Figure 2. Rapid Application Development Model Illustration
(source: https://kissflow.com/application-development/rad/rapid-application-development/

Based on Figure 2, it can be seen that the stages in the Rapid Application Development (RAD) model are as follows:

a) Requirements Planning, at this stage the researcher carries out the process of planning the system, software, and hardware requirements used according to user needs. The results of the requirements planning stage include the main processes in the online exam system, the features used in the online exam system, and the software and hardware used in application development.

b) User design, this stage is carried out using Unified Modeling Language (UML) tools in the form of use case diagrams, activity diagrams, and class diagrams, then creating a user interface design.

c) Development, at this stage the application is developed in accordance with the previously created design.

d) Implementation and Testing, at this stage the application is tested using the black box testing method before finally the application is validated by experts.

1.4 Preliminary Field Testing

At this stage, application validation is carried out by experts on the online exam system that has been created and developed. Based on the results of this stage, it is determined whether the research can be continued to the next stage or returned to the design and development stage.

2.5 Main Field Testing

At this stage, the researcher implemented the application that had been validated to students of class assess the effect of using the application in reducing fraud that occurs.

2.6 Operational Product Revision

After obtaining the implementation results data, data analysis is then carried out based on the results of the application implementation. The data analysis technique used is the Post-study System Usability Questionnaire (PSSUQ) method. PSSUQ consisted of 16 questions and is used to see the results of user assessments of the application, which is used to gauge user's need and satisfaction (Lewis, 1992; Malik & Frimadani, 2023). PSSUQ is a reliable user measuring instrument consisted in 16 questions even after it was translated across language (Al-Tahat, 2021). On the PSSUQ, a lower score indicates that the application is being assessed as getting better, which means that an application that is quite good is an application that has a score below the upper limit of the PSSUQ scale assessment rules. Following are the PSSUQ scale assessment rules can be seen in Table 1.

Table 1. PSSUQ Scale Scoring Rules

Sub Scale	**Scale Scoring Rules**			
		Lower Limit	**Average**	**Upper Limit**
SysUse	Average of Questions 1 – 6	2.57	2.8	3.62
InfoQual	Average of Questions 7 – 12	2.79	3.02	3.24
IntQual	Average of Questions 13 – 15	2.28	2.49	2.71
Overall	Average of Questions 1 - 16	2.62	2.82	3.02

The PSSUQ method formula can be seen in Formula 1.

$$Sub\ scale = \frac{the\ total\ score\ of\ respondents\prime\ assessments\ from\ each\ subscale}{the\ number\ of\ question\ item\ numbers\ for\ each\ subscale}$$

Formula 1. PSSUQ Scale Calculation

Furthermore, the rating scale method was also used to see the influence of using the application on increasing the effectiveness of the evaluation. The following is the formula for calculating the rating scale (Formula 2),

$$\frac{score\ from\ data\ collection}{ideal\ score}\ x\ 100\%$$

Formula 2. Rating Scale Calculation

The results of the rating scale calculation can be classified in table 2.

Table 1. Rating Scale Classification Representation

Percentage Score (%)	Interpretation
P ⩽	Very not Good
20% < P ⩽ 40%	Not Good
40% < P ⩽ 60%	Enough
60% < P ⩽ 80%	Good
80% < P ⩽ 100%	Very Good

3. RESULT AND DISCUSSION

3.1 Research and Information Collecting

a) Literature Study

The results of a literature study of previous research regarding the use of online examination systems and efforts to reduce student academic cheating conclude that object detection is very important to use in evaluation media, especially in online examination systems which must be powerful enough to facilitate various aspects of evaluation and overcome the problem of cheating.

b) Interview

The results of interviews with teachers and school principals regarding the obstacles teachers face in conducting learning evaluations using exam evaluation media conclude that the obstacles faced by teachers in evaluating student learning through exams cause difficulties in distinguishing student ability results and potential cheating. This results in the learning evaluation process being less effective and sometimes leads to subjective evaluations, violating the principle of evaluation objectivity. In the context of the COVID-19 pandemic in 2020 - 2022, teachers recognize the importance of an online-based examination system as a solution for distance learning. Apart from that, global and national digitalization trends also provide additional reasons to consider using an online-based examination system. By overcoming these obstacles and utilizing technology, online examination systems can become an effective means of evaluating learning, ensuring objectivity, and supporting a learning process that is more adaptive and relevant to current digital developments.

c) Observation

The results of observations with teachers and school principals regarding the examination system currently used by SMK Pasundan 1 Cimahi concluded that the use of an examination system which is currently still limited to basic features causes obstacles in reducing student cheating and affects the effectiveness of assessment and evaluation of learning by teachers. The existence of limited features, including the absence of special features such as the ability to generate test results automatically, also requires teachers to carry out manual assessments of student answers. Therefore, further development is needed in the design of the examination system to improve the ability to overcome student cheating, optimize the evaluation process, and support teachers' work more efficiently.

3.2 Planning

Based on the results of research and information collecting through literature study, interviews, and observation techniques, the problem that occurred can be formulated as that SMK Pasundan 1 Cimahi is aware of the need for an examination system that can overcome the problem of cheating during student evaluation, thereby increasing the effectiveness of the learning evaluation process by teachers. while maintaining objectivity and increasing the validity of the evaluation. The desired examination system must also be able to adapt to distance learning scenarios, thereby ensuring a smooth evaluation process.

3.3 Develop Preliminary Form of Product

This stage produces an application that has been developed, the interface used in the application includes the following,

a) Login Page

This display is the display for entering the application. The login page display can be seen in Figure 3.

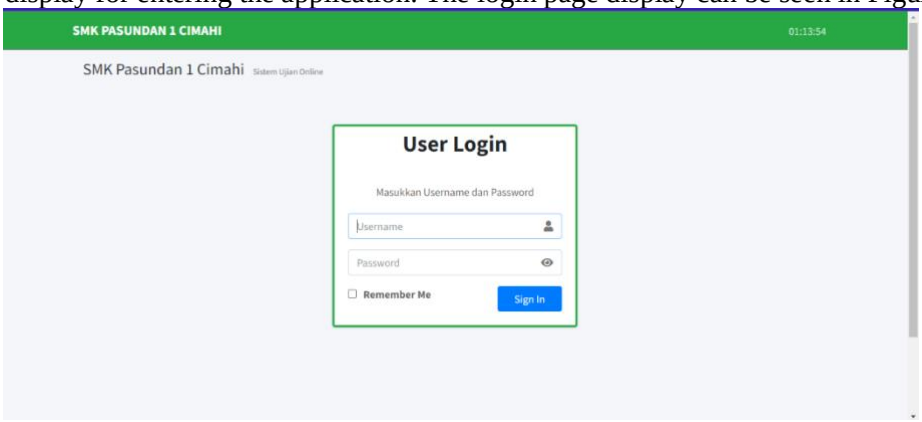

Figure 3 Login Page

b) Student Dashboard Page

This display will appear if the person entering the application has the student role. On this page, there is some information, namely a list of exams that have/have not been taken, and students can see the results of exams that have been taken or take exams that can be taken. The display of the student dashboard page can be seen in Figure 4.

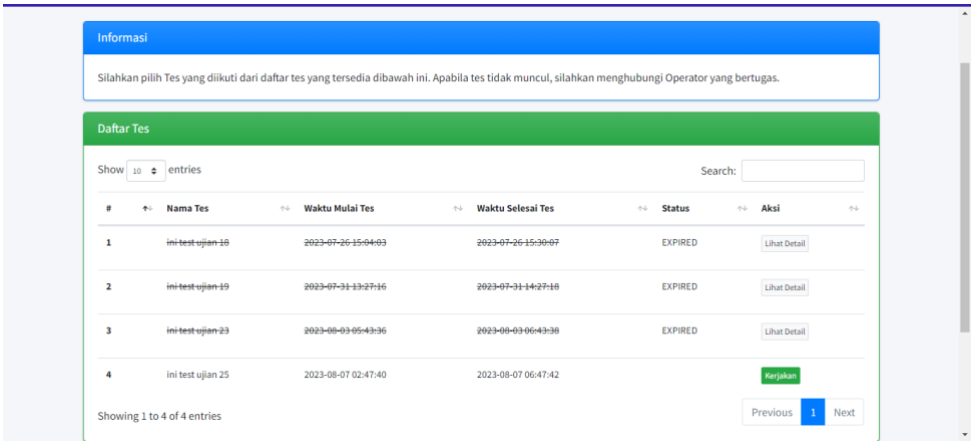

Figure 4. Student Dashboard Page

d) Exam Result Page

This page will appear when the student wants to display the results of the exam they have taken. On this page there is some information, namely, grade, student name, number of correct/wrong answers, start time of the exam, and end time of the exam. The exam results page display can be seen in Figure 6.

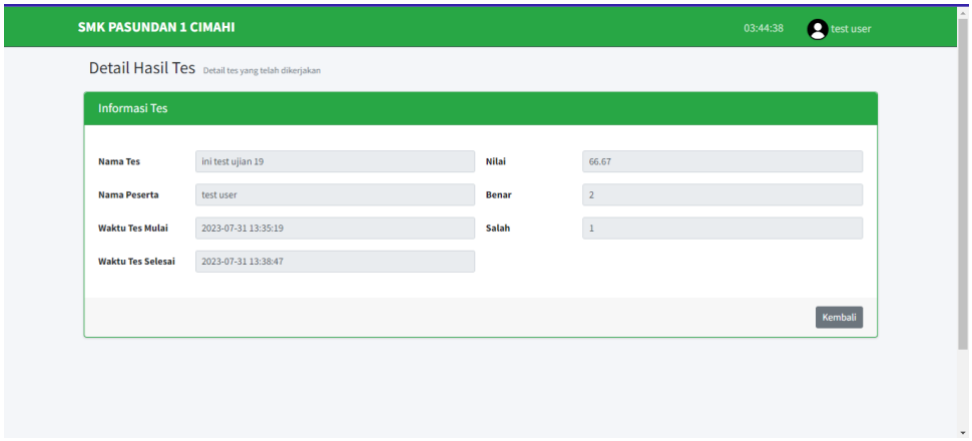

Figure 6. Exam Result Page

e) Admin Dashboard Page

This display will appear if the person entering the application has the admin role, in this display there is some information, namely, the number of students registered in the system, the number of exams that have been created, the number of users who have the admin role, and the number of users who have the super admin role. . On the left there is also a sidebar to make it easier for admins to operate the application. The admin dashboard page display can be seen in Figure 7.

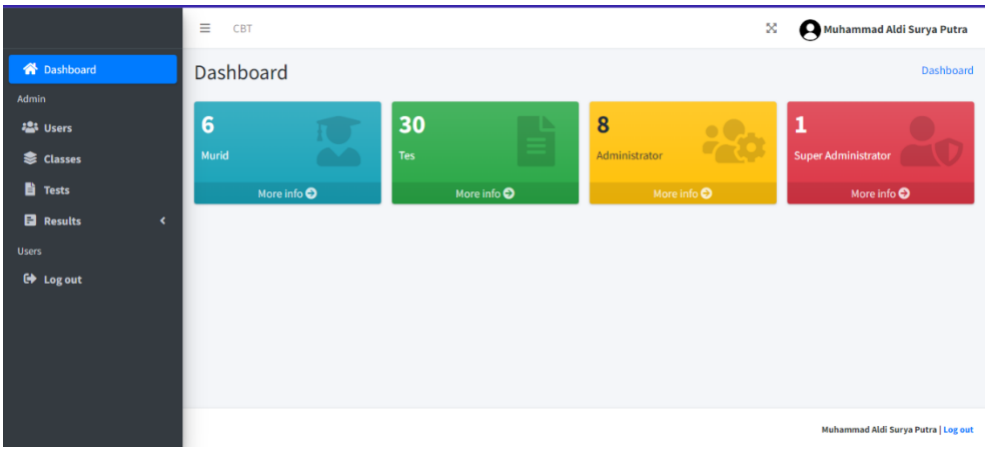

Figure 7. Admin Dashboard Page

f) Student Proctor Page

The Student Proctor page displays the results of the object detection model on student webcam screenshots. This page also has a table containing the results of the object detection model, the table has 7 columns, namely, student webcam screenshot images, eye movements, status of the number of people in the image, head movements up and down, and head movements left and right. The student proctor page display can be seen in Figure 8.

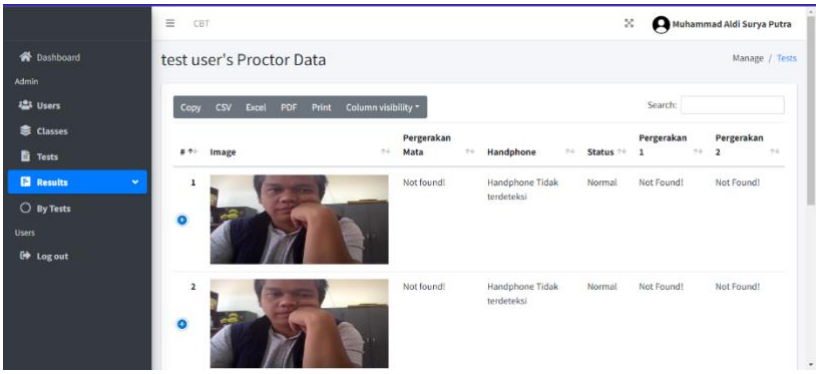

Figure 8. Student Proctor Page

3.4 Preliminary Field Testing

Validation of the application is carried out to find out whether the application that has been developed is suitable for implementation for students or not. The general assessment results by experts of the applications developed are presented in table 3.

Tabel 3. Expert Validation Results

No	Aspect	Number of Examiners	Number of questions	Ideal Score	Score Acquisition	Percentage (%)
1	Functionality	2	3	30	27	90%
2	Reliability	2	3	30	25	83%
3	Usability	2	4	40	37	93%
4	Efficiency	2	2	20	15	75%
			Average			85%

Based on the table above, the results of media validation by two experts obtained validation values for the functionality aspect of 90%, reliability of 83%, usability of 93%, efficiency of 90%. The average score obtained from all aspects was 85% in the "Very Good" category.

3.5 Main Field Testing

Implementation of field testing on the application that has been developed is a learning evaluation media that uses the proctoring feature as an effort to reduce student cheating, namely an Online Examination System based on Object Detection. Implementation begins with conducting daily tests on students using questions given by the teacher, presenting the test results to the teacher, and collecting data on teacher and student responses to the application and the influence of using the application on increasing the effectiveness of the evaluation. The daily exams carried out by students are carried out using 10 questions, with a maximum duration of 60 minutes. Details of the exams carried out by students can be seen in Figure 9.

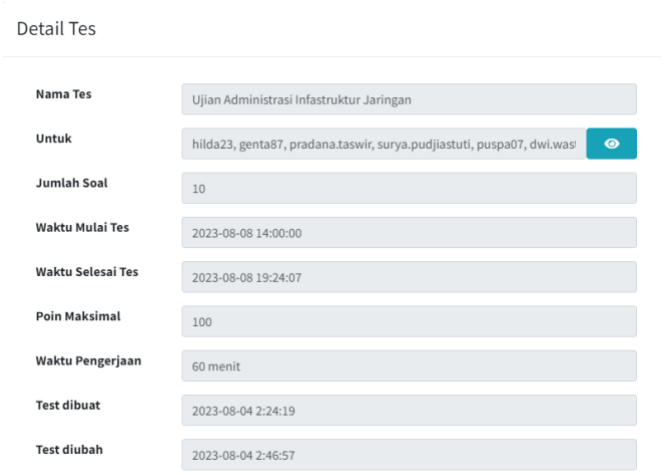

Figure 9. Exam Detail

The next step is to present the results of the examination activities to the teachers. The exam results displayed are the results of proctoring that have been identified by the system. A sample of the proctoring results can be seen in Figure 10.

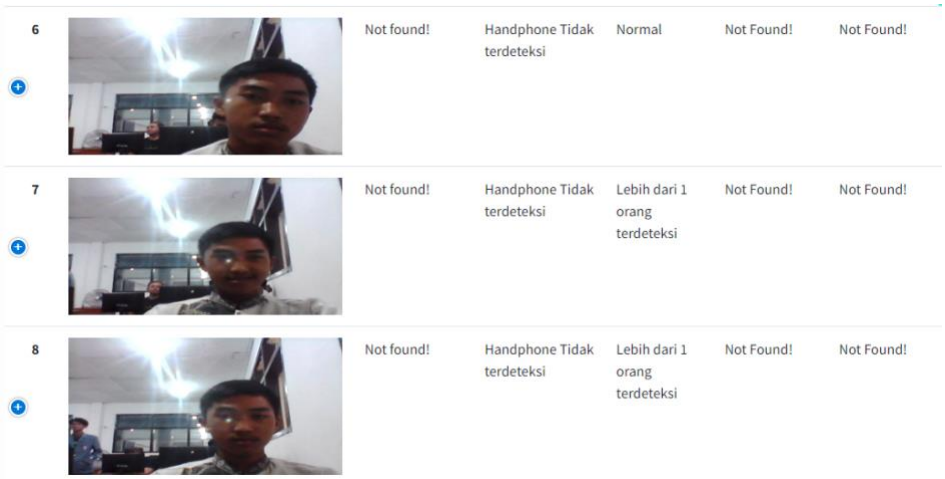

Figure 10. One Student's Proctoring Results

Next is collecting data on teacher and student assessments of the application, as well as collecting data on teachers' opinions regarding the effect of using the application on increasing the effectiveness of evaluations.

3.6 Operational Product Revision

a) Analysis of User Assessment of Applications

The results of the data collection that has been carried out using PSSUQ sets of questions are then analyzed using the formula previously explained on Formula 1, the results of students' and teachers' opinions regarding the application can be seen in Figure 11.

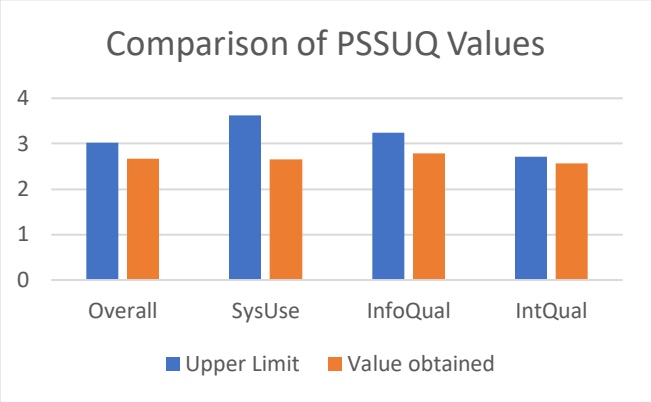

Figure 11. PSSUQ Value Comparison Results

Based on Figure 11, the average value obtained by each variable is below the upper limit of the PSSUQ scale assessment rules, meaning that the application developed is good. This is because on PSSUQ, a lower score indicates a better ranking.

b) Results of Analysis of the Effect of Applications in Reducing Fraud

Next, the results of collecting teacher opinion data are to determine whether the application used can reduce cheating that occurs. The results of this data collection can be seen in Table 4.

Tabel 4. Results of Analysis of the Effect of Applications in Reducing Fraud

Number of Question	Total Score
1	92
2	92
3	94
4	83
5	96
6	96
7	87
8	91
Sum	731
Ideal Score	1000
Percentage	73.1%

Based on Table 4, it can be seen that the use of applications to increase the effectiveness of evaluations is interpreted as "good", which means that the use of applications has a positive effect in reducing student cheating.

4. CONCLUSION

The use of the developed examination system has a positive effect on increasing the effectiveness of evaluation, especially on the principle of objectivity. This is proven by the results of teachers' responses to the increase in evaluation effectiveness after using the online examination system that was developed with an average of 73.1%, which value can be interpreted as "good".

Student and teacher assessments of the object detection-based online examination system are quite good based on assessments using the PSSUQ research instrument. The scores obtained for each aspect of PSSUQ are 2.67 for the Overall aspect, 2.65 for the System Usefulness aspect, 2.79 for the Information Quality aspect, and 2.47 for the Interface Quality aspect. The scores for each of these aspects are below the limits of the PSSUQ assessment rules, which is quite good because it is in line with the PSSUQ principle, namely "Lower scores indicate better quality".

There are several suggestions for this research, namely that it is necessary to refactor the code and also add features so that the processes carried out by the system can be carried out more quickly so that the efficiency of using the application can increase, and the object detection model can be used in real-time so that the exam system can be even better in reduce fraud that occurs.

REFERENCE

Al-Tahat, K. S. (2021). Arabic translation, cultural adaptation and psychometric validation of the post-study system usability questionnaire (PSSUQ). International Journal of Human–Computer Interaction, 37(19), 1815-1822.

Aplin-Snider, C., Buterakos, R., Creech, C., Schapel, S. A., & Feige, B. D. (2021). Academic integrity in online examinations in a graduate nurse practitioner program: Student perceptions and lessons for nurse educators. Nurse Education Today, 107, 105099.

Chen, R., & Zou, M. (2018). Discussion on the relationship between exam-oriented education and quality-oriented education. In 2018 2nd International Conference on Education Innovation and Social Science (ICEISS 2018) (pp. 350-353). Atlantis Press.

Deng, J., Xuan, X., Wang, W., Li, Z., Yao, H., & Wang, Z. (2020). A review of research on object detection based on deep learning. In Journal of Physics: Conference Series (Vol. 1684, No. 1, p. 012028). IOP Publishing.

Gustiani, S. (2019). Research and development (R&D) method as a model design in
educational research and its alternatives. Holistics (Hospitality and Linguistics):
Jurnal Ilmiah Bahasa Inggris, 11(2).

Karthika, R., Vijayakumar, P., Rawal, B. S., & Wang, Y. (2019). Secure online examination system for e-learning. In 2019 IEEE Canadian conference of electrical and computer engineering (CCECE) (pp. 1-4). IEEE.

Hussein, M. J., Yusuf, J., Deb, A. S., Fong, L., & Naidu, S. (2020). An evaluation of online proctoring tools. Open Praxis, 12(4), [509]-525. https://search.informit.org/doi/10.3316/informit.620366163696963

Jia, J. and He, Y. (2022), "The design, implementation and pilot application of an intelligent online proctoring system for online exams", Interactive Technology and Smart Education, Vol. 19 No. 1, pp. 112-120. https://doi.org/10.1108/ITSE-12-2020-0246

Malik, R. A., & Frimadani, M. R. (2023). Lean UX: Applied PSSUQ to Evaluate Less-ON UI/UX Analysis and Design. International Journal of Advances in Data and Information Systems, 4(1), 73-85. https://doi.org/10.25008/ijadis.v4i1.1263

Nalendra, A. K. (2021, March). Rapid Application Development (RAD) model method for creating an agricultural irrigation system based on internet of things. In IOP Conference Series: Materials Science and Engineering (Vol. 1098, No. 2, p. 022103). IOP Publishing.

Nicolaou, C. (2021). Media trends and prospects in educational activities and techniques for online learning and teaching through television content: technological and digital socio-cultural environment, generations, and audiovisual media communications in education. Education Sciences, 11(11), 685.

Rasheed, R. A., Kamsin, A., & Abdullah, N. A. (2020). Challenges in the online component of blended learning: A systematic review. Computers & Education, 144, 103701.

Shraim, K. (2019). Online examination practices in higher education institutions: learners' perspectives. Turkish Online Journal of Distance Education, 20(4), 185-196.

Singh, V., & Thurman, A. (2019). How many ways can we define online learning? A systematic literature review of definitions of online learning (1988-2018). American Journal of Distance Education, 33(4), 289-306.

Zou, Z., Chen, K., Shi, Z., Guo, Y., & Ye, J. (2023). Object detection in 20 years: A survey. Proceedings of the IEEE.