

An Application of Generative Artificial Intelligence for Automated Rubric-Based Grading

Aplikasi Kecerdasan Artifisial Generatif Untuk Asesmen Pembelajaran Berdasarkan Rubrik

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Abstract — Improving the effectiveness of learning assessments is essential in modern education. Therefore, the use of rubrics as an assessment tool has become crucial. This research aims to develop a web application that facilitates the learning assessment process using rubrics. The main issues faced in conventional assessment processes are inefficiency, especially in providing accurate and prompt feedback to learners, and the time-consuming process of creating rubrics. Hence, a solution is needed to enhance the assessment process by leveraging technology. The system development method used is the System Development Life Cycle (SDLC) with an Agile approach. The web application is built using the Flask framework, with integration of OpenAI's ChatGPT to support automated assessment using rubrics. This application is designed to assist teachers in creating, saving, and managing rubrics efficiently. The research involves stages of needs analysis, design, development, testing, and evaluation. The developed web application successfully provides a solution to enhance the learning assessment process. Features such as automatic rubric creation and automated assessment improve assessment efficiency. This research makes a positive contribution to the development of technology in the context of learning and assessment.

Keywords — artificial intelligence; chatgpt; flask; generative artificial intelligence; rubric assessment; web

Abstrak — Meningkatkan efektivitas penilaian pembelajaran sangat penting dalam Pendidikan modern. Oleh karena itu, penggunaan rubrik sebagai alat penilaian telah menjadi hal yang krusial. Penelitian ini bertujuan untuk mengembangkan aplikasi yang memfasilitasi proses penilaian pembelajaran menggunakan rubrik. Masalah utama yang dihadapi dalam proses penilaian konvensional adalah ketidakefisienan, terutama dalam memberikan umpan balik yang akurat dan cepat kepada peserta didik, serta proses pembuatan rubrik yang memakan waktu. Oleh karena itu, diperlukan Solusi untuk meningkatkan proses penilaian dengan memanfaatkan teknologi. Metode pengembangan sistem yang digunakan adalah Siklus Hidup Pengembangan Sistem dengan pendekatan Agile. Aplikasi ini dibangun menggunakan kerangka kerja Flask, dengan integrasi ChatGPT dari OpenAI untuk mendukung penilaian otomatis menggunakan rubrik. Aplikasi ini dirancang untuk membantu guru dalam membuat, menyimpan, dan mengelola rubrik secara efisien. Penelitian melibatkan tahapan analisis, desain, pengembangan, pengujian, dan evaluasi. Aplikasi yang dikembangkan berhasil memberikan Solusi untuk meningkatkan proses penilaian pembelajaran. Fitur-fitur seperti pembuatan rubrik otomatis dan penilaian otomatis meningkatkan efisiensi penilaian. Penelitian ini memberikan kontribusi positif terhadap pengembangan teknologi dalam konteks pembelajaran dan penilaian.

Kata Kunci — ChatGPT; Flask; kecerdasan artifisial; kecerdasan artifisial generatif; penilaian rubrik; web

I. INTRODUCTION

Education is a key sector in the growth and development of society and the nation. To achieve quality education, learning assessment becomes a crucial factor in evaluating student's understanding of the subject matter [1]. Well-conducted learning assessments can provide valuable information for educators in designing effective learning experiences tailored to the needs of learners. Generally, learning assessment is carried out using instruments such as tests, assignments, or projects, which are evaluated by teachers [2]. However, traditional assessments that rely solely on subjective teacher evaluations may have some drawbacks, such as a lack of objectivity, consistency, and scalability [3].

One approach in learning assessment is the use of assessment rubrics. A rubric is an instrument used to describe and communicate the criteria and levels of performance expected in task or project. This rubric provides clear guidance to students on what is expected of them in achieving learning objective [4]. However, in its implementation, rubric-based assessment still faces several challenges. One of them is the difficulty in consistently and objectively creating rubrics. Subjective assessments can impact the validity and reliability of assessment result, as well as increase variability among assessors [5]. Additionally, the process of developing adequate rubrics also requires significant time and effort.

To solve these problems, we can use artificial intelligence to create a good system for learning assessments. Artificial intelligence is a growing trend and is being used in many parts of lives. The use of this technology has revolutionized the daily lives and work processes of people. Many AI-based systems are commonly used in the field of education, especially for those involved in Computer Science [6]. In the [7] study, the focus is on student feedback, which serves as an evaluation tool to enhance quality. They employ machine learning to handle the extensive data analysis. This is followed by the [8] study, which also utilize machine learning methods to analyze the gathered data. The method employed in the [7], [8] studies is a machine learning technique known as support vector machine. By leveraging artificial intelligence, it is

possible to develop a learning assessment application that can automatically generate assessment rubrics based on an understanding of assessment criteria and provided performance examples [9].

Several related studies serve as the foundation, consideration, and references in the preparation of this research, research by Segara did a study on utilizing rubrics to review course introductions in social ponders. He clarified how to form a rubric and separated the evaluation into distinctive levels. The research found that rubrics are great way to asses learning decently and methodical [10]. Alex Chambers did a studied about how students can be more engaged in learning. The key is for students to understand, enjoy, and actively participate in what they are learning. To make this happen, they use grading rules called rubrics. These rubrics help students evaluate their own work with a little help from teacher, so they better what they can do [11]. In the study by Shidiq is around how Artificial Intelligence, like ChatGPT, can help progress imaginative composing aptitudes. The consider found that AI can be super accommodating in instruction nearly like having an educator. It is great at evaluating subjective things and can make the assessment handle quicker [12]. Kaldaras considered how to break down a science assessment into diverse parts. They isolated it into seven categories to keep it nitty gritty and solid. Combining these parts appeared that the appraisals coordinated well with an easier by and large rating. This keeps evaluation viable and point by point [13]. Balqis did a study utilizing online courses (MOOCs) to evaluate courses better. They included AI to naturally score essays, saving time compared to people. The researchers found that AI is nice at understanding current innovation hones and making them way better [14]. The study [15], they collected data to see in case ChatGPT makes a difference with composing and reviewing papers. The discoveries appear that student do not believe ChatGPT to review alone. Presently, they see it more as a supportive instrument that needs human supervision and cautious believe. Smith did a study using assessment rubrics to evaluate inter-rater variability in assessments by exploring AI assessment solutions. The conclusion is that students still lack confidence in AI solutions for assessing software design evaluations [16]. Suwarno explains the importance of assessment rubrics for measuring the honesty of students. He concludes that assessment rubrics are beneficial for students [17].

H. A. Simon said that Artificial Intelligence (AI) is a research, application and instruction area related to computer programming to perform something that – from human perspective is considered intelligent. Rich and Knight define Artificial Intelligence as a study on how to make computers perform tasks that are currently done better by humans [18]. Meanwhile, based on The New International Webster's Comprehensive Dictionary of the English Language, Encyclopedic Editions, Artificial Intelligence is mentioned as a field of study in computer science related to the development of computers capable of processes resembling human thinking. It is also stated that AI involves the concept of machines that can adapt, learn, and serve as an extension of human intelligence through computer usage.

The Generative Artificial Intelligence is an innovative approach that allows machines to learn from previously collected data and adapt to new situations. GAI can generate vast amounts of new textual (s.a., ChatGPT12) and visual (s.a., Dall-E13) output based on written prompts through combining existing data in a new way. GAIs are becoming more competent and more capable of replicating information from the web, including a range of services for complex digital tasks such as coding, template creation, and business administration [19]. GAI has emerged as a crucial technology in creating newly synthesized virtual artifacts or improving semi-synthesized augmented artifacts [20].

Generative Artificial Intelligence has the potential to replace certain occupations such as writers, due to its capacity to equalize and even surpass human capabilities in various planning aspects. Products of GAI can significantly enhance writing productivity, for example, by automating relatively routine and time-consuming subcomponents like translation and draft creation [19], [21]. There is four of the most common techniques by GAI:

1) *Generative Adversarial Networks*

This technique uses a pair of Neutral Network, that is generator synthesizes the content and the second known as discriminator that can evaluates the authenticity of the generator's content. The network repeat this generate/discriminate until the generator produces content that cannot discern by discriminator between real and synthetic.

2) *Generative Pre-trained Transformer*

This technique generate text in other languages and can make human-sounding words, sentences, and paragraphs on almost any topic and writing style. These have grown over several generations that increased parameter set trained for each, on a more extensive online textual corpus than the previous.

3) *The Generative Diffusion model*

This model synthesizes content by taking a training data distribution, gradually adding noise, and learning the way to recover the data as a reversal of the noise alternative process. The data are generated from any sampled noise through the learned denoising process.

4) *Geometric DL*

Geometric DL (GDL) seeks to comprehend, interpret, and articulate AI models using geometric principles. These principles have already undergone comprehensive exploration in various domains, including grids, transformations within homogeneous spaces, graphs, and vector bundles.

An assessment rubric, also called a grading rubric, is like a checklist that helps teachers evaluate how well students did on a task. It gives clear instructions on what is expected in terms of quality, quantity, and understanding in an assignment.

The assessment rubric consists of a series of categories or assessment dimensions reflecting the main components or aspects of performances that need to be evaluated. Each category or dimension has descriptions outlining different levels of achievement, ranging from very low to very high levels. Typically, assessment rubrics are organized in the form of a table or matrix, with assessment criteria as rows and

levels of achievement as columns. Rubrics can align expectations and learning outcomes between learners and educators, thereby enhancing evaluation transparency by letting them know what will be assessed in assignment [22].

Several advantages of using rubrics include communicating achievement expectations for each task to students, providing information and feedback, assisting in delivering consistent and fair assessments, thereby encouraging students learning intentions and self-assessment [23]. Using assessment rubrics helps teachers give fair and consistent grades to students. It also allows teachers to give specific feedback on what students did well and where they can improve. These rubrics help students understand what is expected in assessments and provide clear guidelines to reach learning goals.

By observing several issues in manual rubric creation and assessment, including the lack of consistency and subjectivity among assessors, and the time-consuming nature of rubric development, there is a need for a more modern solution. Therefore, an application of generative artificial intelligence for automated rubric-based grading is needed. Just like in the [24], [25] study that used LMS to collect the data, we will also employ the same approach in this current research. This app is meant to help teachers make assessment checklists fairly and consistently, reducing differences among assessors. We also hope it makes creating grading lists easier for teachers, giving them more time to improve the quality of their assessments. The rest of this paper is organized as follows: in Section 2, we elaborate on the research methods we employ along with a description of the application design. Subsequently, the results and discussion are presented in section 3, and in section 4, we conclude our research and provide some possibilities for future works.

II. METHOD

A. Research Procedure

This research will follow several stages to ensure that the research activities proceed smoothly and systematically. Mention in Figure 1, the planned stages to be carried out for structured research are Literature Review, Needs Analysis, Design and Development, System Testing and Analysis, Conclusions and Recommendations.

1) Literature Review

A literature review is conducted by gathering data from journals, articles, books, videos, related research, and other sources. At this stage, the author will engage in learning about assessment rubrics, generative artificial intelligence, the Python programming language, web application development, and other topics related to this research.

2) Needs Analysis.

In this stage, the researcher gathers requirements before conducting the research. The necessary preparations, such as tools, materials, and other essentials, should be identified at this stage. Additionally, supplementary literature is required as a guide in the creation of this research.

3) Design and Development

The creation of this application will utilize the Agile System Development Life Cycle method. This method aligns with the researcher's needs in the developing the

application, considering its high flexibility that allows the researcher to adapt to design changes during development. The stages in this method include Planning, Design, Development, Testing and Deployment.

4) Testing and System Analysis

In this stage, the application that has been developed will undergo testing. The testing will be conducted based on scenarios to ensure that the functions of each feature operate as expected.

5) Conclusion

This stage represents the final phase to summarize the overall results of the conducted research and provide useful recommendations for future studies.

B. Application Design

The application to be developed is an online application. To enhance its flexibility, the application will be web-based. The target users include educators or anyone who implements and requires assessment rubrics for evaluations, including students. The application will be built using the OpenAI-made chatbot, ChatGPT, requiring an API key from ChatGPT.

The application can generate assessment rubrics that include assessment criteria, assessment categories, and a grading scale. The rubrics is generated based on the criteria entered by the educator and is automatically produced by the application. Educators can modify the generated rubric according to their needs.

From the student's perspective, they can view their achievement results based on the submitted assignments. The system will automatically mark the criteria fulfilled according to the submitted assignments, providing an evaluation for the students.

C. Design

Before building the application, a system design is required. In this stage, the application design will include elements such as Business Case, Use Case Diagram, Application Architecture, Entity Relationship Diagram, and Activity Diagram. The Business Case outlines the primary interactions and functionalities of the application, detailing the actions of both teachers and students and the conditions under which certain warnings will be displayed as discuss in TABLE 1.

With conditions: if there is no assessment rubric when submitting an assignment, a warning will appear: "No assessment rubric available." From the teacher's perspective, if assignments have been submitted but not assessed, a warning will appear: "No assessment rubric available."

TABLE 1
ACTION BY ACTORS

Actor	Action
Teacher	Adds a rubric Enters rubric criteria and it will be automatically generated by the application The rubric produces assessments categories, achievement levels, and a grading scale
Learner	View assessment results Submits an assignment View assessment results The relevant categories for the submitted assignment are highlighted The result is presented based on the achievement in each category



Figure 1. Research Procedure

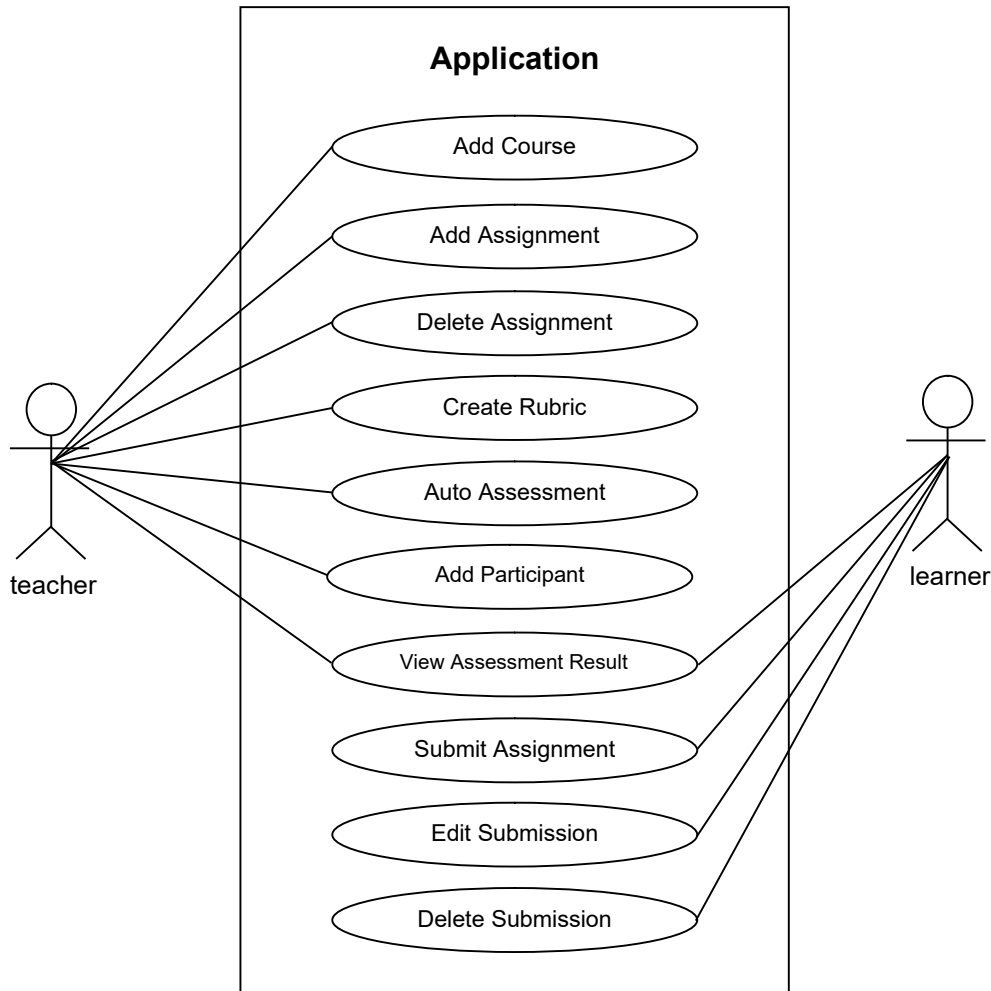


Figure 2. Use Case Diagram

Figure 2 shows the Use Case Diagram of the application. The application is designed for two actors: Teacher and Learner. The actor’s teacher is allowed to add course, add assignment, delete assignment, create rubric, auto assessment, add participant, view assessment result. And the actor learners are allowed to view assessment results, submit assignment, edit submissions, and delete submission.

The depicted Activity Diagram in following figure represents the core functionality of the application, focusing on the automatic creation of rubrics and assessments. Figure 3 illustrate the Activity Diagram for the automatic generating rubrics. The process begins on the assessment tab in the application, where the user inputs the desired rubric request. After entering the request, the user presses the Extract button. The entered request is then sent to ChatGPT for processing. Once ChatGPT provides the results, the system captures and saves them to the database. Subsequently, the system redirects

to the Rubric Page, displaying the captured results in a table format.

Figure 4 outlines the Activity Diagram for automatic assessment. This process occurs on the submission page, where the learner’s answer submission is displayed. When the user presses the Score button, the request is sent to ChatGPT. After receiving the results, the system captures and stores them in the database. The system the redirects to the Assessment page and highlights the cells in the rubric table according to the captured results from ChatGPT.

Figure 5 shown the Application architecture. The application to be developed is a web-based application. It will be integrated with Generative Artificial Intelligence product in the form of a chatbot, namely ChatGPT. Assessed feature does by ChatGPT. Therefore, an API key from ChatGPT is required to connect the web application to the ChatGPT server for the application to function.

For analytical purposes, the assessed feature will not be entirely automated, but there will also be an option for manual assessment. To access the application, users must use a browser to connect to the application hosted on a web server, and each application feature is connected to a MySQL database.

Figure 6 depicts the Entity Relationship Diagram of the developed application. The constructed application will have 7 main entities, namely grades, users, course, assign, submission, rubric, and result. These entities are interconnected and have cardinalities as indicators of the existence and the quantity of values within each entity. The built entities will form a database named “db_flask”

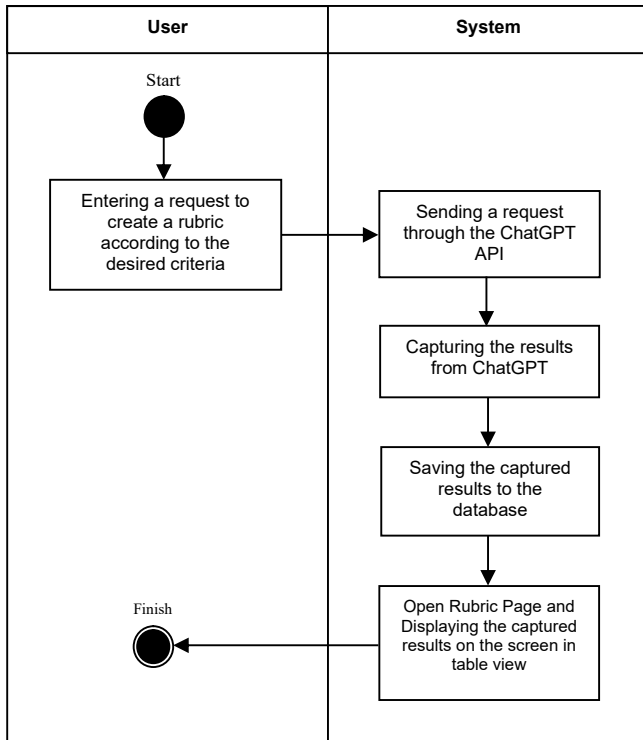


Figure 3. Generating Rubric's Activity Diagram

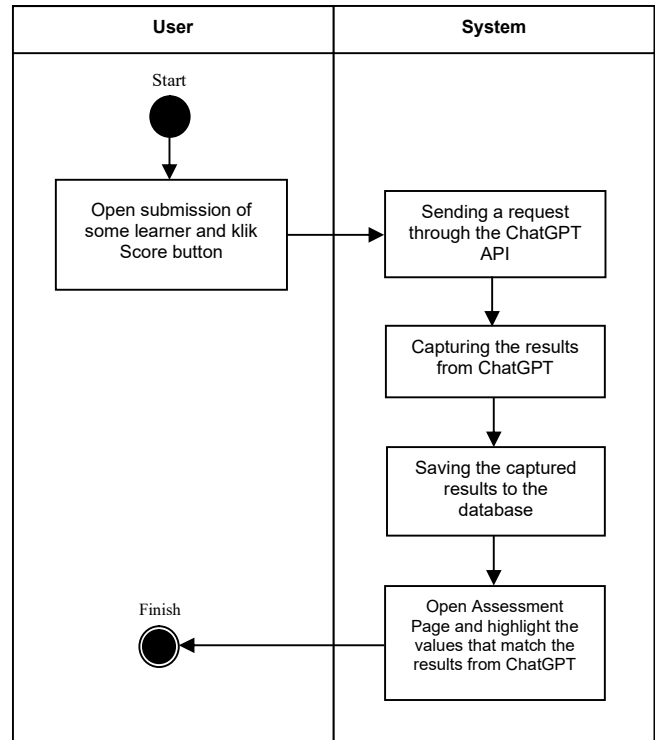


Figure 4. Automatic Assessment Activity Diagram

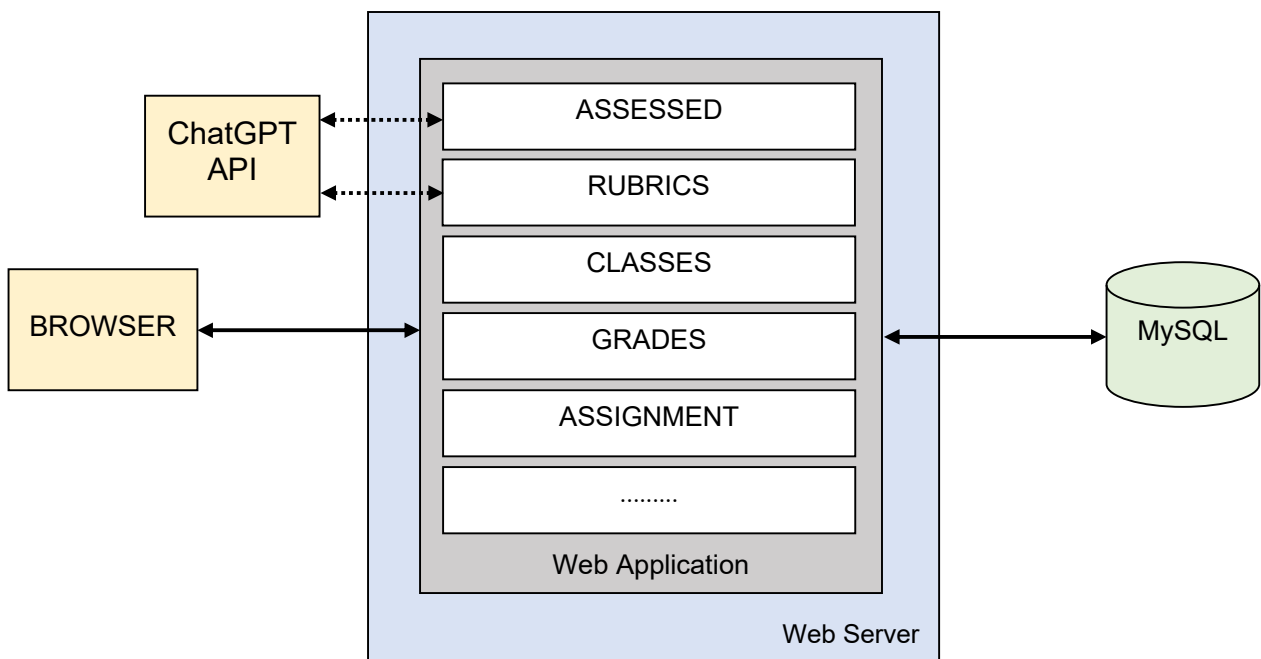


Figure 5. Application Architecture

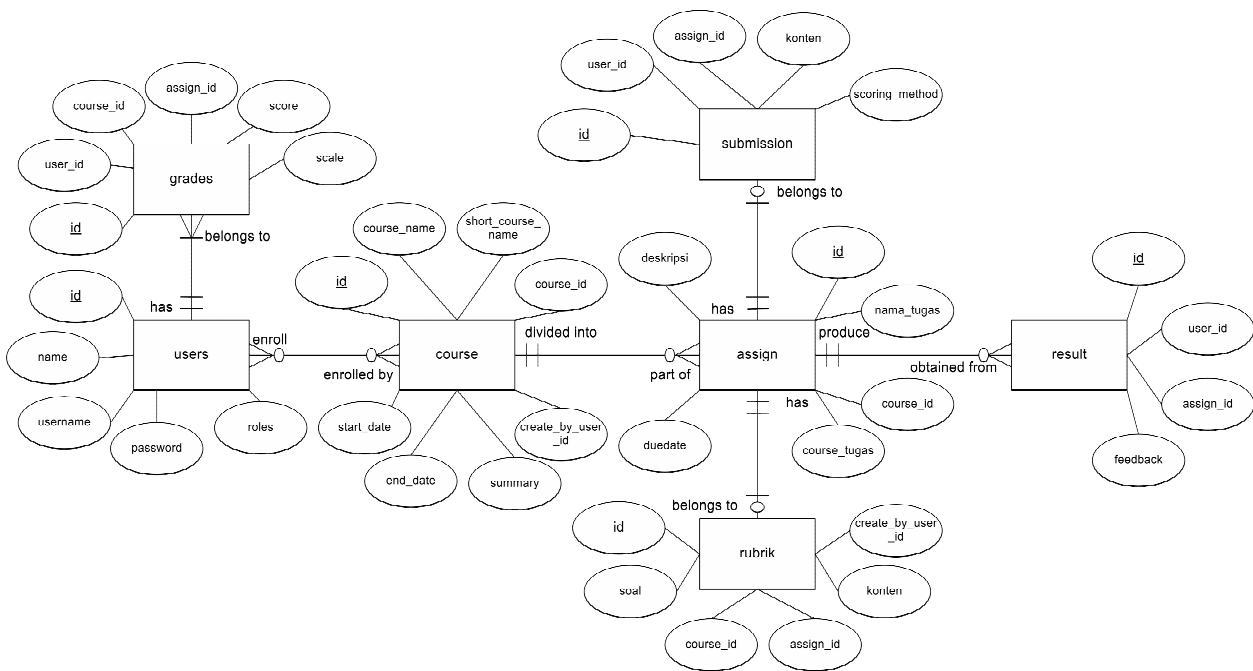


Figure 6. Entity Relationship Diagram

TABLE 2
ENDPOINTS / ROUTES AND ACCESS RIGHTS

Method	Path	Access Right
GET, POST	/registrasi	Guest
GET, POST	/login	Guest
GET, POST	/buatkelas	Teacher
GET, POST	/kelas/tugas/buatrubrik/id_tugas=<int:id_assign>	Teacher
GET, POST	/kelas/course/tambah-tugas/id=<int:id_course>	Teacher
GET, POST	/kelas/tugas/grade/id=<int:id_assign>& user_id=<int:id_user>	Teacher
GET, POST	/kelas/course/tugas/submission/id=<int:id_course>&id_tugas=<int:id_tugas>	Teacher, Learner
POST	/kelas/course/tugas/edit-submission/id=<int:id_assign>	Teacher, Learner
POST	/kelas/course/tugas/hapus-submission/id=<int:id_assign>	Teacher, Learner
POST	/process_data/id=<int:id_assign>& user_id=<int:id_user>	Teacher
POST	/simpan_nilai/id=<int:id_assign>&user_id=<int:id_user>	Teacher
POST	/tambah_partisipan/id=<int:id_course>	Teacher
GET	/kelas/course/id=<int:id>	Teacher, Learner
GET	/kelas/grades/id=<int:id>	Teacher, Learner
GET	/home	Teacher, Learner
GET	/logout	Teacher, Learner
GET	/user	Teacher, Learner
GET	/kelas/tugas/grading/id=<int:id_course>& id_tugas=<int:id_assign>	Teacher
GET	/get_hasil/id=<int:id_assign>& user_id=<int:id_user>	Teacher

GET	/kelas/tugas/hasil/id=<int:id_assign>& id_user=<int:id_user>	Teacher, Learner
GET	/kelas/course/tugas/id=<int:id_course>& id_tugas=<int:id_tugas>	Teacher, Learner
GET	/kelas/participants/id=<int:id>	Teacher, Learner
GET	/get_data/id=<int:id_assign>	Teacher, Learner
GET	/rubrik/id_tugas=<int:id_assign>	Teacher, Learner

III. RESULTS AND DISCUSSION

Based on the outlined methodologies, several outcomes have emerged from this research. In accordance with the stages specified in the application development methodology, this section will delve into the implementation and testing of the application. To facilitate the researcher in conducting the study, a Learning Management System (LMS) application has been constructed to fulfill various research requirements.

A. End Points and Access Rights

The application is built using the Flask microframework, which separates HTML code and logic for database access. Therefore, the built-in Flask library, Jinja, is employed to facilitate the connection between the application’s front-end and back-end. TABLE 2 represents all the endpoints/routes and access rights.

B. Testing

After the application or system is developed, the next step involves testing the application. The objective is to assess the functionality and features of the system to determine whether they operate effectively. Testing is conducted based on predefined scenarios, and the results are documented as shown in Error! Not a valid bookmark self-reference..

TABLE 3
SYSTEM TESTING

No	Description	Result Expected	Actual Result	Notes
1	Login Page	After entering the registered username and password and clicking "Login", access the application according to the user's role	Successfully registered users' login and access the application according to their role	Success
2	Registration Page	After filling out the form, selecting role and clicking "Regis", access the application according to the user's role	User successfully registered and accesses the application according to their role	Success
3	Homepage (Teacher)	Displays all Course created with the logged-in account	The system successfully displays all Courses created with the logged-in account	Success
4	Homepage (Learner)	Displays all enrolled Courses	The system successfully displays all enrolled Courses	Success
5	Add Course Page (Teacher)	After filling out the form and clicking "Submit", it will return to the homepage, and the Course Item will be displayed	The system successfully adds a Course, return to the homepage, and displays the Course Item	Success
6	Add Assignment Page (Teacher)	After filling out the form and clicking "Tambahkan Tugas," it will return to Course Item Page and display all existing Assignments	The system successfully adds an Assignment and displays it on the Course Item page	Success
7	Submission Page (Learner)	After filling put the form and clicking "Submit", the data will be saved, and the information changes to "Sudah Mengajukan", and the data is allowed to be edited or deleted	The system successfully saves the data, changes the information to "Sudah Mengajukan" and displays the data on the existing form and can be edited or deleted	Success
8	Assessment Page (Teacher)	After filling out the form with desired rubric and clicking "Extract", it will display the rubric in table form	The system successfully displays the rubric according to the criteria entered on the form	Success

9	Grading Item Page (Teacher)	The user clicks "Score", redirect to the Result Page and display the rubric table with highlighted criteria	The system successfully redirects to the Result Page and displays the rubric table with highlighted criteria	Success
10	Assessment Page (Learner)	If the assessment has been done by the teacher, it will display the rubric table that has been highlighted	The system successfully displays the rubric table that has been highlighted because there is already an assessment result	Success
11	Grades Page	Displays all grades according to the assessment results	The system displays all grades according to the assessment results	Success

Figure 7. Add Assignment

Ketepatan Hasil	Hampir selalu salah	Sering salah	Cukup akurat	Sering akurat	Hampir selalu akurat
Pemahaman Konsep	Tidak memahami konsep	Kurang memahami konsep	Cukup memahami konsep	Sering memahami konsep	Begitu baik dalam memahami konsep
Penggunaan Strategi	Tidak menggunakan strategi	Kurang menggunakan strategi	Cukup menggunakan strategi	Sering menggunakan strategi	Selalu menggunakan strategi
Kerja Sama	Tidak bisa bekerja sama	Kurang bisa bekerja sama	Cukup bisa bekerja sama	Sering bisa bekerja sama	Selalu bisa bekerja sama
Penggunaan Alat Bantu	Tidak menggunakan alat bantu	Kurang menggunakan alat bantu	Cukup menggunakan alat bantu	Sering menggunakan alat bantu	Selalu menggunakan alat bantu

Figure 8. Create Rubric

C. Implementation

To run the application, various parameters need to be specified. It is important to note that the application requires the API key from ChatGPT as the GPT parameter. In its implementation, this application using GPT-3.5 model. Next, define parameters for the test, including questions and answers. For determining the scores, a rubric must first be created based on the question parameters. The assessment process will be carried out automatically, with textual answers from students as input and automatic scoring based on the rubric as output. Figure 7 show the assignment creation and Figure 8 show the rubric creation.

The teacher creates a class. After that, the teacher adds learner users to the class. The teacher creates an assignment, and learners access the class to complete the assignment by entering their answers in the provided textbox. Once the answers are saved, if a rubric has been created, the teacher can proceed with the assessment. If a rubric has not been created, it needs to be created based on the existing assignment. If the conditions are met, the assessment can be conducted. The scores will appear automatically, and the criteria that meet the requirements will be highlighted.

Testing is done using questions or assignments with both exact and non-exact materials. This is to validate the assessment using AI. The exact materials will used mathematics question and the non-exact materials will used biological question. The question of the exact material will depart into 3 level of difficulty. And the non-exact material, will be categorized into 2 different answer formats with the same question. The parameters for the questions and answers to be tested are in accordance with the TABLE 4.

After entering the input into the application and running the evaluation, the results will be shown in the existing figure. We

have created different categories for exact materials. This was done to assess the accuracy for the mathematical questions at each difficulty level. Before we discuss rating accuracy, let's first take a look at the rubric generated by ChatGPT. There are some non-required assessment items that will affect the overall score. In the case of exact material with an easy level, the results like the shown in Figure 9. The same goes for questions of moderate difficulty shown in Figure 10 and intermediate level shown in Figure 11.

In contrast to the assessment results for non-exact material. To analyze the results of non-exact material, we created the same rubric using different response parameters. The obtained results can be considered consistent with expectations. Evaluation results for complete answers as shown in Figure 13 receive higher score that incomplete answers as shown in Figure 12 for the corresponding criteria. The results of the evaluation performed show that the evaluation is performed even when a particular evaluation dimension is not required. From each test conducted, the time to get feedback from ChatGPT is according to internet speed.

TABLE 4
EXAMPLE QUESTIONS AND ANSWERS

Material	Level	Question	Answer
Exact	Easy	Determine the x from the equation of $2x - 5 = 7$	$2x - 5 = 7$ $2x = 7 + 5$ $2x = 12$ $x = 12/2$ $x = 6$
	Moderate	Calculate the value of $\sin(30^0) + \cos(0^0)$	$\sin(30^0) = 1/2 = 0,5$ $\cos(0^0) = 1$ $\sin(30^0) + \cos(0^0) = 1,5$
	Intermediate	Determine $h(x) = f(g(x))$, with $f(x) = 3x + 1$ and $g(x) = 2x - 4$	$h(x) = f(g(x))$ $f(g(x)) = 3(2x - 4) + 1$ $f(g(x)) = 6x - 12 + 1$ $f(g(x)) = 6x - 11$
Non-Exact	Incomplete complete	Explain the process flow of the human digestive system	The process begins when human eat a food from mouth. There is mechanical breakdown by tooth. Then it goes to stomach and after it expelled through anus. The human digestive system processes ingested food through mechanical and chemical breakdown. Beginning in the mouth, it continues through the esophagus to the stomach and small intestine for nutrient absorption. The large intestine absorbs water, and waste is expelled through the rectum and anus. This system ensures vital nutrient extraction.

Penilaian
Nilai : 88

Ketepatan Hasil	Hampir selalu salah	Sering salah	Cukup akurat	Sering akurat	Hampir selalu akurat
Pemahaman Konsep	Tidak memahami konsep	Kurang memahami konsep	Cukup memahami konsep	Sering memahami konsep	Begitu baik dalam memahami konsep
Penggunaan Strategi	Tidak menggunakan strategi	Kurang menggunakan strategi	Cukup menggunakan strategi	Sering menggunakan strategi	Selalu menggunakan strategi
Kerja Sama	Tidak bisa bekerja sama	Kurang bisa bekerja sama	Cukup bisa bekerja sama	Sering bisa bekerja sama	Selalu bisa bekerja sama
Penggunaan Alat Bantu	Tidak menggunakan alat bantu	Kurang menggunakan alat bantu	Cukup menggunakan alat bantu	Sering menggunakan alat bantu	Selalu menggunakan alat bantu

Simpan Penilaian Kembali

Penilaian
Nilai : 64

Ketepatan Menggunakan Rumus	Rumus digunakan dengan sangat tidak tepat atau tidak digunakan	Rumus digunakan dengan cukup tepat	Rumus digunakan dengan baik dan benar	Rumus digunakan dengan sangat baik dan benar	Rumus digunakan dengan sangat sempurna dan benar
Pemahaman Konsep	Pemahaman konsep sangat minim	Pemahaman konsep cukup baik	Pemahaman konsep baik	Pemahaman konsep sangat baik	Pemahaman konsep sangat mendalam
Kemampuan Memecahkan Masalah	Kemampuan memecahkan masalah sangat lemah dan tidak ada upaya untuk memecahkan	Kemampuan memecahkan masalah cukup baik dengan beberapa kesalahan	Kemampuan memecahkan masalah baik dengan sedikit kesalahan	Kemampuan memecahkan masalah sangat baik dengan beberapa kesalahan kecil	Kemampuan memecahkan masalah sangat baik tanpa kesalahan
Kreativitas dalam Mempresentasikan Solusi	Tidak ada upaya kreatif dalam mempresentasikan solusi	Beberapa upaya kreatif dalam mempresentasikan solusi	Ada beberapa ide kreatif dalam mempresentasikan solusi	Terdapat ide kreatif yang baik dalam mempresentasikan solusi	Ada banyak ide kreatif yang inovatif dalam mempresentasikan solusi
Kerapihan dan Kebersihan Makalah	Makalah sangat tidak rapi dan tidak bersih	Makalah cukup rapi dan bersih	Makalah rapi dan bersih	Makalah sangat rapi dan bersih	Makalah sangat rapi, bersih, dan teratur

Simpan Penilaian Kembali

Figure 9. Result of Exact Material Easy Level

Figure 10. Result of Exact Material Moderate Level

Penilaian
Nilai : 84

Keberanian Jawaban	Jawaban tidak akurat dan tidak memahami konsep composite function	Jawaban kurang akurat dan masih belum sepenuhnya memahami konsep composite function	Jawaban cukup akurat dan memahami konsep composite function, namun terdapat sedikit kekeliruan	Jawaban akurat dan menguasai konsep composite function dengan baik	Jawaban sangat akurat dan mendalam, dan mampu mengaitkan konsep composite function dengan konsep lain secara terperinci
Pemecahan Masalah	Tidak mampu mengidentifikasi kesalahan dalam penggunaan composite function	Kurang mampu mengidentifikasi kesalahan dalam penggunaan composite function, namun masih memerlukan bantuan	Cukup mampu mengidentifikasi kesalahan dalam penggunaan composite function tanpa bantuan	Mampu mengidentifikasi kesalahan dalam penggunaan composite function dan memberikan solusi alternatif dengan baik	Mampu mengidentifikasi kesalahan dalam penggunaan composite function dan memberikan solusi alternatif dengan baik
Penalaran	Tidak mampu menjelaskan alasan atau proses penalaran dalam penggunaan composite function	Kurang mampu menjelaskan alasan atau proses penalaran dalam penggunaan composite function, namun kurang sistematis	Cukup mampu menjelaskan alasan atau proses penalaran dalam penggunaan composite function secara sistematis	Mampu menjelaskan alasan atau proses penalaran dalam penggunaan composite function secara sistematis dan mendalam	Mampu menjelaskan alasan atau proses penalaran dalam penggunaan composite function secara sistematis dan mendalam
Kejelasan dan Keterbacaan	Tidak jelas dan sulit untuk dipahami	Kurang jelas dan masih membingungkan	Cukup jelas, namun masih perlu beberapa tambahan	Jelas dan mudah dipahami	Sangat jelas, terstruktur dengan baik, dan sangat mudah dipahami
Penggunaan Bahasa	Tidak menggunakan bahasa komunikasi matematika yang baik dan benar	Kurang menggunakan bahasa komunikasi matematika yang baik dan benar	Cukup menggunakan bahasa komunikasi matematika yang baik dan benar	Menggunakan bahasa komunikasi matematika yang baik dan benar	Menggunakan bahasa komunikasi matematika yang baik dan benar dengan lancar dan percaya diri

Simpan Penilaian Kembali

Figure 11. Result of Exact Material Intermediate Level

Penilaian
Nilai : 76

Ketepatan dan Keekaragaman Penjelasan	Penjelasan sangat tidak tepat dan memiliki keekaragaman yang sangat terbatas	Penjelasan tidak tepat dan memiliki keekaragaman yang terbatas	Penjelasan cukup tepat namun memiliki keekaragaman yang terbatas	Penjelasan cukup tepat dan memiliki keekaragaman yang cukup	Penjelasan sangat tepat dan memiliki keekaragaman yang baik
Ketepatan dan Keekaragaman Contoh	Contoh yang diberikan sangat tidak tepat dan memiliki keekaragaman yang sangat terbatas	Contoh yang diberikan tidak tepat dan memiliki keekaragaman yang terbatas	Contoh yang diberikan cukup tepat namun memiliki keekaragaman yang terbatas	Contoh yang diberikan cukup tepat dan memiliki keekaragaman yang cukup	Contoh yang diberikan sangat tepat dan memiliki keekaragaman yang baik
Ketepatan dan Keekaragaman Visualisasi	Visualisasi yang digunakan sangat tidak tepat dan memiliki keekaragaman yang sangat terbatas	Visualisasi yang digunakan tidak tepat dan memiliki keekaragaman yang terbatas	Visualisasi yang digunakan cukup tepat namun memiliki keekaragaman yang terbatas	Visualisasi yang digunakan cukup tepat dan memiliki keekaragaman yang cukup	Visualisasi yang digunakan sangat tepat dan memiliki keekaragaman yang baik
Ketepatan dan Keekaragaman Sumber Referensi	Sumber referensi yang digunakan sangat tidak tepat dan memiliki keekaragaman yang sangat terbatas	Sumber referensi yang digunakan tidak tepat dan memiliki keekaragaman yang terbatas	Sumber referensi yang digunakan cukup tepat namun memiliki keekaragaman yang terbatas	Sumber referensi yang digunakan cukup tepat dan memiliki keekaragaman yang cukup	Sumber referensi yang digunakan sangat tepat dan memiliki keekaragaman yang baik
Ketepatan dan Keekaragaman Konsistensi Jawaban Terhadap Pertanyaan	Jawaban sangat tidak tepat dan tidak konsisten terhadap pertanyaan	Jawaban tidak tepat dan tidak konsisten terhadap pertanyaan	Jawaban cukup tepat namun memiliki konsistensi yang terbatas terhadap pertanyaan	Jawaban cukup tepat dan memiliki konsistensi yang cukup terhadap pertanyaan	Jawaban sangat tepat dan memiliki konsistensi yang baik terhadap pertanyaan

Simpan Penilaian Kembali

Figure 12. Result of Non-exact Material Incomplete Answer

Penilaian
Nilai : 100

Ketepatan dan Keekaragaman Penjelasan	Penjelasan sangat tidak tepat dan memiliki keekaragaman yang sangat terbatas	Penjelasan tidak tepat dan memiliki keekaragaman yang terbatas	Penjelasan cukup tepat namun memiliki keekaragaman yang cukup	Penjelasan sangat tepat dan memiliki keekaragaman yang baik
Ketepatan dan Keekaragaman Contoh	Contoh yang diberikan sangat tidak tepat dan memiliki keekaragaman yang sangat terbatas	Contoh yang diberikan tidak tepat dan memiliki keekaragaman yang terbatas	Contoh yang diberikan cukup tepat namun memiliki keekaragaman yang cukup	Contoh yang diberikan sangat tepat dan memiliki keekaragaman yang baik
Ketepatan dan Keekaragaman Visualisasi	Visualisasi yang digunakan sangat tidak tepat dan memiliki keekaragaman yang sangat terbatas	Visualisasi yang digunakan tidak tepat dan memiliki keekaragaman yang terbatas	Visualisasi yang digunakan cukup tepat namun memiliki keekaragaman yang cukup	Visualisasi yang digunakan sangat tepat dan memiliki keekaragaman yang baik
Ketepatan dan Keekaragaman Sumber Referensi	Sumber referensi yang digunakan sangat tidak tepat dan memiliki keekaragaman yang sangat terbatas	Sumber referensi yang digunakan tidak tepat dan memiliki keekaragaman yang terbatas	Sumber referensi yang digunakan cukup tepat namun memiliki keekaragaman yang cukup	Sumber referensi yang digunakan sangat tepat dan memiliki keekaragaman yang baik
Ketepatan dan Keekaragaman Konsistensi Jawaban Terhadap Pertanyaan	Jawaban sangat tidak tepat dan tidak konsisten terhadap pertanyaan	Jawaban tidak tepat dan tidak konsisten terhadap pertanyaan	Jawaban cukup tepat namun memiliki konsistensi yang terbatas terhadap pertanyaan	Jawaban sangat tepat dan memiliki konsistensi yang baik terhadap pertanyaan

Simpan Penilaian Kembali

Figure 13. Result of Non-exact Material Complete Answer

IV. CONCLUSION AND FUTURE WORKS

This research has successfully analyzed, designed, and developed an application of generative artificial intelligence for automated rubric-based grading. The created application has been implemented effectively. The system can automatically generate rubrics based on user-provided requests. The automation process can save time and effort in composing rubrics and conducting assessments. The features created align with the objectives of this research, facilitating educators in rubric creation through generative artificial intelligence assistance. All user needs, as per the use case diagram, have been fulfilled, and all functionalities and features have been tested with results matching expectations.

Some suggestions for future works include the addition of new features to enhance functionality and utility, as well as the optimization of generative artificial intelligence algorithms for more accurate rubric outcomes. Then improvements to the algorithm to address the variety of responses provided by ChatGPT are necessary. There is also a need for enhancements to features for submitting input in file format. It is Necessary to add features for course history and assignment history, as well as create a more engaging user interface for the application. By considering these conclusions and recommendations, it is hoped that this application will continue to evolve and provide a positive contribution in efficiently supporting rubric-based learning assessment processes.

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