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# MODEL PEMBELAJARAN TERINTEGRASI: PENGGABUNGAN PENDEKATAN BERBASIS PROYEK DAN KONSEP SDLC UNTUK MATA PELAJARAN REKAYASA PERANGKAT LUNAK, DIEVALUASI MELALUI EUCS.

# *INTEGRATED LEARNING MODEL: A BLEND OF PROJECT-BASED APPROACH AND SDLC CONCEPTS FOR SOFTWARE ENGINEERING COURSES, EVALUATED THROUGH EUCS*

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***ABSTRACT***

*Online learning and face-to-face learning are two examples of current learning models. Online learning has the advantage of time and place flexibility as it can be conducted remotely. Meanwhile, face-to-face learning excels in the teacher-student relationship as they can meet in person. However, particularly in online learning, not all subjects can be taught optimally, such as practical courses. Blended learning is one solution for a combined learning model that can leverage both online and face-to-face learning. One of the most challenging subjects in online learning is software engineering, which requires practical exercises to write application code. There are various types of blended learning models, but we propose a blended learning model specifically based on the Software Development Lifecycle (SDLC) pattern in software engineering course materials. We do this to maximize the learning process. We also integrate blended learning with a project-based concept, as this course is well-suited for project-based learning. In evaluating this model, we analyze the satisfaction level using the end-user computing satisfaction method. The sample consists of 60 students from the Computer Science program, selected using accidental sampling. The data analysis and processing methods employed in this study include t-tests, F-tests, and multiple linear regression. The research yields a satisfaction level of 71%. The results of hypothesis testing also show that the variables Ease of Use and Timeliness have a significant positive partial impact on student satisfaction.*

***Keyword:*** *Learning models, Blended learning, Software engineering, project-based learning, SDLC, End-user computing satisfaction*

**ABSTRAK**

Pembelajaran daring dan pembelajaran tatap muka adalah dua contoh model pembelajaran saat ini. Pembelajaran daring memiliki keunggulan fleksibilitas waktu dan tempat karena dapat dilakukan secara jarak jauh. Sementara itu, pembelajaran tatap muka unggul dalam hubungan guru-murid karena mereka dapat bertemu langsung. Namun, khususnya dalam pembelajaran daring, tidak semua mata pelajaran dapat diajarkan secara optimal, seperti mata pelajaran praktik. Pembelajaran gabungan adalah salah satu solusi untuk model pembelajaran yang menggabungkan baik pembelajaran daring maupun tatap muka. Salah satu mata pelajaran yang paling menantang dalam pembelajaran daring adalah rekayasa perangkat lunak, yang memerlukan latihan praktis untuk menulis kode aplikasi. Ada berbagai jenis model pembelajaran gabungan, tetapi kami mengusulkan model pembelajaran gabungan yang didasarkan pada pola Siklus Pengembangan Perangkat Lunak (SDLC) dalam materi kursus rekayasa perangkat lunak. Kami melakukannya untuk memaksimalkan proses pembelajaran. Kami juga mengintegrasikan pembelajaran gabungan dengan konsep berbasis proyek, karena kursus ini cocok untuk pembelajaran berbasis proyek. Dalam mengevaluasi model ini, kami menganalisis tingkat kepuasan menggunakan metode kepuasan komputasi pengguna akhir. Sampel terdiri dari 60 mahasiswa program Ilmu Komputer, dipilih menggunakan teknik sampling kebetulan. Metode analisis dan pengolahan data yang digunakan dalam penelitian ini melibatkan uji t, uji F, dan regresi linear berganda. Penelitian ini menghasilkan tingkat kepuasan sebesar 71%. Hasil pengujian hipotesis juga menunjukkan bahwa variabel Kemudahan Penggunaan dan Ketepatan Waktu memiliki dampak parsial positif yang signifikan terhadap kepuasan mahasiswa.

**Kata Kunci:** Model pembelajaran, Pembelajaran gabungan, Rekayasa perangkat lunak, Pembelajaran berbasis proyek, SDLC, End-user computing satisfaction

## INTRODUCTION

For several years the traditional face-to-face learning model has been used in the academic system. This model provides material in the classroom and students learn from the teacher. In the process, in addition to providing knowledge in the classroom, the traditional learning model also has a culture that makes students interact and work together. The relationship between students and teachers is even closer because they often meet. However, this learning model is not always good because students and teachers have to meet in one place so that this model is limited in space and time. In addition, sometimes this model limits students independent learning to explore their abilities (Alaneme et al., 2010).

In the 21st century technology is increasingly advanced and internet technology is becoming a part of everyday life. In this century there is also a technology called e-learning. E-learning by definition is technology-based learning in which learning materials are delivered electronically to remote learners via computer networks (Chikurteva et al., 2020). After the Covid-19 pandemic hit, e-learning has become one of the favourite tools in student learning. E-learning has the advantage that it is not limited by space and time. Learning can be done anywhere and anytime. However, learning with e-learning still has disadvantages. The main disadvantages of e-learning include: 1. Students often copy answers on the internet without understanding the content of the lesson, 2. Students are lazy because they find it easier to access resources via the internet, 3. Lack of personal relationships, 4. low motivation and student self-control (Melicheríková & Busikova, 2012).

In addition, e-learning in certain courses may be difficult to implement. An example is a course that focuses on practical activities. Teachers will find it difficult to give practical examples directly to students because they can only give examples remotely. Students also find it difficult to practice what is exemplified by the teacher because they cannot see it directly. Therefore, e-learning in certain courses cannot be implemented optimally.

One of the courses that is difficult to implement using only e-learning is software engineering courses. This course requires practical activities: designing applications, writing program code, testing applications, and deploying applications.

Therefore, in order to maximize the learning process in software engineering courses, one of the learning models that can be applied is blended learning. Blended learning is an approach that combines the advantages of traditional learning and e-learning, thereby providing students with more opportunities for independent learning and interaction (Yi et al., 2017). In this paper, the author proposes a blended learning model approach for software engineering courses. The blended learning model is made by combining the SDLC (software development life cycle) process between face-to-face and online learning.

Currently there are various models of blended learning. The flipped classroom model is the most widely used model. In this model, students work online at home and study the content provided by the teachers and then face to face to do assignments such as practicum assignments. Other blended learning models are Station Rotation, Lab Rotation, Individual Rotation, Flex Model, Enriched-virtual Model and others (Lyz et al., 2020).

Project-based learning is a project-based learning model based on constructive learning theory in which students become active constructors of their knowledge and as cooperative/collaborative learners (Zhi, 2016). PBL makes students work together to solve real problems in the real world. PBL can be combined with blended learning by dividing project activities between online and face-to-face.

Finally, to test the proposed model, we employed the End-user Computing Satisfaction analysis method. This method is commonly used to evaluate applications, such as e-learning applications, as

demonstrated in the research conducted by Purwandani and Putera (Purwandani, 2018; Putera & Candiasa, 2021), However, we observed that this method could be applied to test this model because it encompasses five variable measurements: content, accuracy, format, ease of use, and timeliness (Aditia Angga Perdana et al., 2021) which can be implemented in evaluating this model. Another study by Dyah (Puspito Rini, 2019)concluded that this method is suitable for determining the final level of participant satisfaction, making it appropriate for use with this model to assess the ultimate satisfaction level of participants after learning through this method

## METHOD

This research is a study that develops a model and measures it using the end-user computing satisfaction (EUCS) method. The research method refers to the stages of the research and development method. The research method used by the author involves conducting a literature review of related previous studies, followed by the following stages: material development, testing, implementation, and review with EUCS.

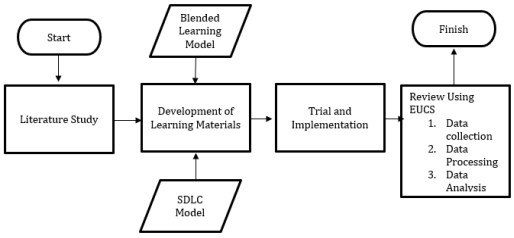


**Figure 1. Research Method**

(1) Literature Review

The literature review is conducted to compare and find ideas for implementing blended learning in the software engineering course. A literature review is necessary to discover principles and models that can be applied to the upcoming research.

(2) Learning Material Development

In this stage, analysis is carried out based on the results of the literature review. Learning materials are then developed by combining the SDLC model and blended learning concepts.

(3) Testing and Implementation

Testing is conducted by directly teaching in the classroom based on the previously prepared materials.

(4) Review

This stage involves a final review of the teaching process. The review is conducted to measure whether the developed method aligns with the objectives or not. This review utilizes the EUCS method. The steps involved in this method include data collection through distributing questionnaires, data processing consisting of validity testing, reliability testing, classic assumption testing, hypothesis testing, multiple linear regression analysis, and user satisfaction level calculation.

## RESULT AND DISCUSSION

Software engineering course is a course that discusses material how to build an application with the principles of engineering expertise to get economical software that is reliable and works efficiently on real machines (Pressman & Maxim, 2014).

This course is guided by the SDLC principle or software development lifecycle, meaning that the learning process will follow the SDLC process rules including: planning, problem analysis, application design, application construction/development, application testing/deployment, and maintenance (S, 2017). Of all the stages of SDLC, not all of them can be maximally delivered by the teacher online. Therefore, in this paper, we will discuss blended learning with project-based concepts for teaching this course.

This paper is intended to create a blended learning model with a project-based concept. The blended learning approach will be adapted to software engineering courses and SDLC concepts. Therefore, this learning will be divided into 6 phases according to the SDLC phase.

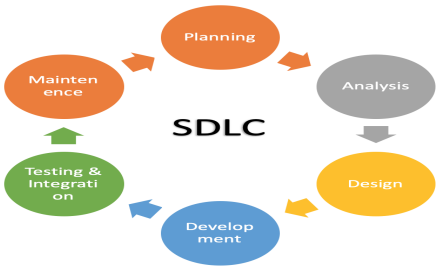


**Figure 2. SDLC Method**

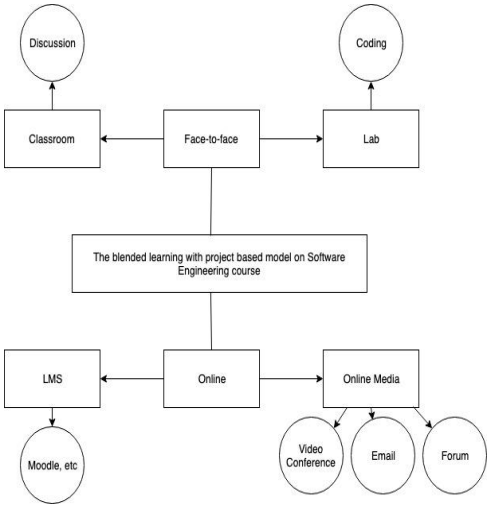


**Figure 3. Blended Learning Project Based Media**

For teaching Blended learning we will divide it into 2 parts: face-to-face learning and online learning. Face-to-face learning is divided into 2 places: the classroom for discussion and the lab for practice. While online learning is also divided into 2 parts: using LMS (Learning Management System) such as Moodle applications and online media such as chat, forums, email, or video conferences.

As for the learning process, the authors divide it into SDLC phases:

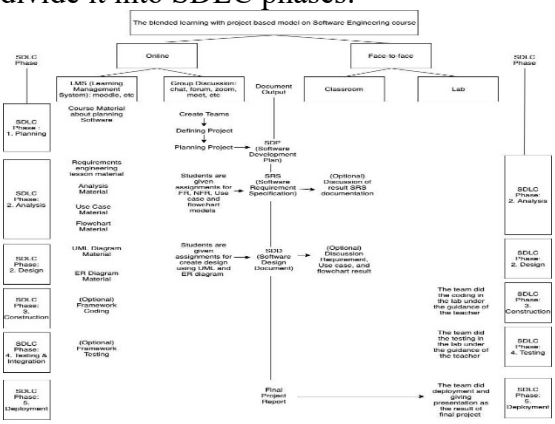

**Figure 4. Blended Learning Model with Project Based**

1. Planning Phase

In this phase, most of the learning is online. The LMS application is used to provide material on software planning and SDP (software development plan) report templates. Then by using media such as forums or chat, teachers can assign students to form project teams in this course. The teacher can give the topic to the team that has been formed or the team determines the topic itself. The teacher can then direct the team to prepare a project plan document. The SDP report will be the output of this planning phase.

2. Analysis Phase

This phase begins when the teacher provides material on requirements engineering through the LMS. Then the team is assigned to collect requirements from the relevant users. After that, the team will arrange user requirements into FR (functional requirements) and NFR (non-functional requirements). From FR and NFR, teachers can direct the team to create models including: use case models, domain models, and flowchart models. All these assignments can be given by the teacher to the team through online media.

From this phase, the team was then assigned to create an SRS (software specification system) document. Then as an option, the teacher can have face-to-face discussions about the results of the SRS that have been made by the team. The teacher can guide the team from the SRS results that have been made by the team before going to the next phase.

3. Design Phase

This phase is the software design phase. Teachers can start by providing materials through the LMS to design a software. Teachers can also provide material for models that can be used in describing software designs such as UML diagrams and ERD diagrams.

The team is then assigned by the teacher to design an application that will be made based on an existing standard

diagram (UML, etc.). In this phase, the teacher can also guide the team with a face-to-face process in class so that the team prepares the design correctly. The output of this phase is SDD (software design document). In building a design in this phase, the teacher must guide the team so that the design that is built is in accordance with the requirements that have been set.

4. Construction Phase

This phase is when the team starts building or coding the program. Teams can code programs in the computer lab under the guidance of a teacher. Teachers must be able to guide the team in the program development process. The teacher must pay attention to how the program code is written and how the team divides the work among its members. In addition, teachers can also provide resources such as programming frameworks that can be used by the team.

In this phase we recommend that teams use git tools to collaborate between teams. Then we also suggest that the teacher can guide the team to write program code with the concept of clean code (clean program code such as no duplicates, no unused variables, etc).

5. Testing & Integration phase

This phase is when the team has completed their program. However, this phase can also be carried out simultaneously with the construction phase. In the lab, the team, guided by the instructor, tested the program that had been made and also integrated it with the components involved. In addition, teachers in this case can also provide materials on testing and integration that can be stored in the LMS.

In this phase, we suggest that testing be automated by using tools (cypress, etc.). The testing carried out is also at least a unit test and a black box test. Then we also suggest that teams use CI/CD (continuous integration/continuous deployment) concepts in building their program. Teams can also use CI/CD tools to facilitate their program development

6. Deployment phase

After the program is created and testing is run, the team can deploy the application. The team can also make a presentation as the final project result in front of the class to be discussed together. This phase is the last phase in learning, but in fact there is one more phase, namely the maintenance phase. This phase may not be practiced directly because the teaching time has finished, but in addition the teacher can provide materials to be studied when the application made must be maintained.

***Measurement using EUCS***

EUCS is a method to measure the final satisfaction level by comparing expectations and reality (Muhamad Son Muarie & Fathiyah Nopriani, 2020). In this study, expectations will be measured against the realities experienced by participants/students after engaging in learning with this model. EUCS itself consists of 5 variables: content, accuracy, format, ease of use, and timeliness. Before commencing the measurements, as stipulated in Rikzam's research(Kamal et al., 2020) , it is imperative to specify the 5 EUCS variables relevant to the model to be assessed.

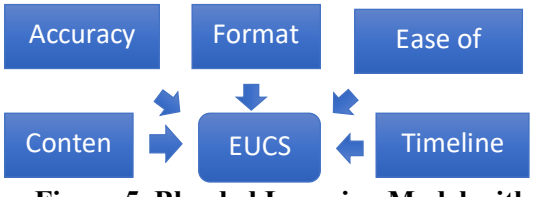


**Figure 5. Blended Learning Model with Project Based**

*Content*: Measuring participant satisfaction based on their understanding of software engineering materials.

*Accuracy*: Assessing participant abilities through tests conducted at the end of the learning process.

*Format*: Evaluating participant satisfaction with the format of the blended learning model.

*Ease of Use*: Gauging participant satisfaction with the flexibility of mixed offline and online learning.

*Timeliness*: Measuring the timeliness of learning throughout one semester by comparing the target in the Study Plan (RPS) with the final test results.

1. Normality Test

The Normality Test is conducted to assess the extent to which the data is distributed normally. The normality tests employed in this research involve the use of the one-sample Kolmogorov-Smirnov test and P-P Plot graph.

**Table 1. One Sample KS test**

| | | Unstandardized Residual |
|---|---|---|
| N | | 85 |
| Normal Parameter | Mean | .0000000 |
| | Std.deviation | 1.05828282 |
| Most Extreme Differences | absolute | .045 |
| | Positive | .045 |
| | Negative | -.041 |
| Test Statistic | | .045 |
| Asymp. Sig | | .200cd |
| a. Test distribution is normal | | |
| b. calculated from data | | |
| c. Lilliefors Significance Correction | | |
| d. This is lower bound of the true significance | | |

Based on Table 1, the Asymp. Sig (2-tailed) value is 0.200, which is greater than 0.05. This indicates that the data is normally distributed. This assessment aligns with the decision criteria outlined by Ghozali (Ghozali, 2018), where a Kolmogorov-Smirnov test with a significance value exceeding 0.05 suggests normal distribution of residual data. Furthermore, the normality assessment is supported by visual observations from the P-P plot graph as depicted below:

The obtained results show scattered points around the diagonal line, indicating that the data is normally distributed and fulfills the assumption of normality.

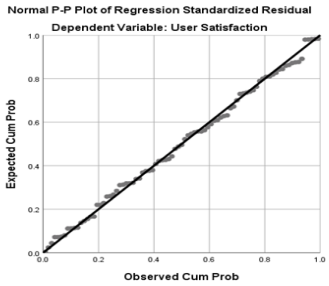


**Figure 5. Normal Probabilty Plt**

2. Multicollinearity Test

The multicollinearity test is conducted to evaluate the degree of dependence or strong correlation between two or more independent variables in a regression model. Its purpose is to identify whether there is a multicollinearity issue that could affect the reliability of the regression analysis results.

**Table 2. Multicollinearity Test**

| | | | Coefficients[1] | | | | |
|---|---|---|---|---|---|---|---|
| | Unstandardized Coefficients | | Standardized Coefficients | | | Collinearity | Statistics |
| Model | B | Std. Error | Beta | t | Sig. | Tolerance | VIF |
| 1 (Constant) | -.459 | .664 | | -.692 | .491 | | |
| Content | .041 | .066 | .063 | .623 | .535 | .403 | 2.482 |
| Accuracy | -.076 | .098 | -.092 | -.780 | .438 | .298 | 3.350 |
| Format | .089 | .076 | .144 | 1.174 | .244 | .273 | 3.666 |
| Ease of Use | .148 | .059 | .314 | 2.510 | .014 | .264 | 3.794 |
| Timeliness | .344 | .072 | .476 | 4.797 | .000 | .419 | 2.386 |

Based on Table 2, it is observed that the tolerance values for the 5 variables (content, accuracy, format, ease of use, and timeliness) are above 0.1, and the VIF values are less than 10. This result leads to the conclusion that multicollinearity is not present.

3. Heteroscedasticity Test

The purpose of the heteroscedasticity test is to assess whether the variability of residuals (model errors) in regression analysis is constant or not across the range of values of the independent variable. Heteroscedasticity occurs when the variability of residuals is not constant, which can impact the validity of regression results and the interpretation of the model. The heteroscedasticity test in this study was carried out by looking at the scatterplot graph

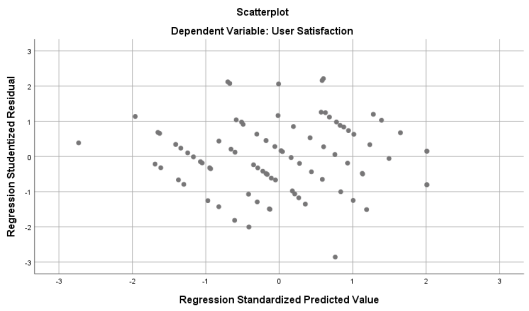


**Figure 6. Scatterplot**

Based on figure 4, it can be seen that there is no clear pattern and the points are

spread above and below the number 0 on the Y axis, so it can be said that heteroscedasticity does not occur.

4. T-Test

The purpose of the T-test is to examine whether the difference between two sample means is statistically significant. The T-test is widely used in statistical analysis and can have various applications, depending on the context of its use.

**Table 3. Test T Result**

| | | | Coefficients | | | | |
|---|---|---|---|---|---|---|---|
| | Unstandardized Coefficients | | Standardized Coefficients | | | Collinearity | Statistics |
| Model | B | Std. Error | Beta | t | Sig. | Tolerance | VIF |
| 1 (Constant) | -.459 | .664 | | -.692 | .491 | | |
| Content | .041 | .066 | .063 | .623 | .535 | .403 | 2.482 |
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| Ease of Use | .148 | .059 | .314 | 2.510 | .014 | .264 | 3.794 |
| Timeliness | .344 | .072 | .476 | 4.797 | .000 | .419 | 2.386 |

In the obtained results, the Content variable yielded a t-value of 0.623, which is less than the critical t-value of 1.990, indicating that the Content variable does not exert a significant influence on User Satisfaction. Similarly, the Accuracy variable obtained a t-value of -0.780, falling below the critical t-value of 1.990, suggesting that Accuracy does not play a significant role in determining User Satisfaction. Additionally, the Format variable obtained a t-value of 1.174, which is less than the critical t-value of 1.990, implying that Format does not significantly affect User Satisfaction. On the contrary, the Ease of Use variable has a t-value of 2.510, surpassing the critical t-value of 1.990, signifying a substantial impact on User Satisfaction. Lastly, the Timeliness variable achieved a t-value of 4.797, exceeding the critical t-value of 1.990, affirming its significant influence on User Satisfaction.

5. F-Test

The F-test is commonly used in statistics to test the significance of differences between two or more groups or treatments.

**Table 4. F-Test**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 194.119 | 5 | 38.824 | 32.605 | .000[b] |
| | Residual | 94.069 | 79 | 1.191 | | |
| | Total | 288.188 | 84 | | | |

Based on the obtained results, the calculated F-value is 32.605, exceeding the critical F-table value of 2.33. Therefore, it can be concluded that the variables content, accuracy, format, ease of use, and timeliness collectively have a significant impact on User Satisfaction.

6. Coefficient of Determination

**Table 5. Determination Coefficient**

**Model Summary[b]**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .821[a] | .674 | .653 | 1.09121 |

a. Predictors: (Constant), Timeliness , Content , Format , Accuracy , Ease of Use

b. Dependent Variable: User Satisfaction

Based on the data in Table 5, it was found that the adjusted R-square value for the coefficient of determination is 0.653. This indicates that the variables content, accuracy, format, ease of use, and timeliness collectively influence user satisfaction by 65.3%, while other unexamined factors contribute to the remaining variability.

7. Multiple Linear Regression Test

**Table 6. Result Multiple Linear Regression Test**

| | | | | Coefficients* | | |
|---|---|---|---|---|---|---|
| | | | | Standardized | | |
| | Unstandardized Coefficients | | | Coefficients | | |
| Model | B | | Std_Error | Beta | t | Sig. |
| 1 | (Constant) | -459 | 664 | | -692 | 491 |
| | Content | 041 | 066 | 063 | 623 | 535 |
| | Accuracy | -76 | 098 | -.092 | -780 | 438 |
| | Format | 089 | 076 | 144 | 1,174 | 244 |
| | Ease of Us | 148 | 059 | 314 | 2,510 | 014 |
| | Timeliness | 344 | 072 | AT6 | 4,797 | 000 |

a. Dependent Variable: UserSatisfaction

The purpose of the Multiple Linear Regression Test is to understand and analyze the relationship between one dependent variable and two or more independent variables. From the analysis results, we can determine the regression coefficients for each independent variable. Consequently, coefficients are obtained for the content variable (X1) at 0.041, accuracy

variable (X2) at -0.076, format variable (X3) at 0.089, ease of use variable (X4) at 0.014, and timeliness variable (X5) at 0.344, with a constant of -0.459.

8. User satisfaction level

**Table 7. User satisfaction level**

| No | Variabel | Score | satisfaction index | conclusion |
|---|---|---|---|---|
| 1 | Content | 1256 | 75% | satisfied |
| 2 | Accuracy | 848 | 67% | satisfied |
| 3 | Format | 1236 | 73% | satisfied |
| 4 | Ease ofUse | 1571 | 74% | satisfied |
| 5 | Timeliness | 833 | 65% | satisfied |
| | Total | 5744 | 71% | satisfied |

Based on Table 7, the overall satisfaction level with the blended learning model is calculated to be 71%. This figure indicates that students are satisfied with this learning model

## CONCLUSION

This paper introduces a blended learning model with a project-based concept approach as a learning model that can be applied to software engineering courses. A project-based concept approach can be added because this course can be turned into a project for students. In addition, with the project-based concept, students can have experience in solving problems that exist in the real world. Then we also adapt the blended learning model to the SDLC concept in software engineering. We added this SDLC concept so that we can manage when the time is right for online learning and when is the right time for face-to-face learning.

To assess the effectiveness of this learning model, we employ measurement using the EUCS method. The measurement results are above 70%, indicating that students are sufficiently satisfied with this learning model. For further research, we plan to create a blended learning model in other courses. Then we will also conduct a comprehensive comparative study with other courses that use blended learning to see the effectiveness of using this blended learning concept

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