Implementation of the E-PBL Learning Model Using the Collassion Learning-App to Maximize the Collaboration and Student Discussion Process in Solving Problems

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***Abstract*—The purpose of this research is to generate an appropriate learning model for the information system analysis and design course. This research was conducted at the Faculty of Information and Communication-Technology, Universitas Teknologi Mataram. This research used the R&D method, which can be used to systematically design new products through various stages. The preliminary research was conducted by distributing questionnaires, which were filled out by 131 students. The questionnaire results described the learning model which includes group assignments and exercises given by lecturers. Also, they desire the involvement of lecturers during and after the class through involving technology. The implementation of the applied learning model consisted of learning steps, reaction principles, social systems, and support systems. The approach helped students to collaborate and discuss effectively, both during and outside lecture hours, devoid of space and time constraints. The model is validated by expert testing, followed by suggestions to improve or revise the design to obtain a final product appropriate to the needs and related to the theoretical principles. The product trials in the field was conducted in three stages, namely One-to-One, Small Group, and Field Trials. The effectiveness test was performed by comparing the initial and final results. The research finding shows that e-PBL-based Information System Analysis and Design learning model was proven effective in increasing students' ability to perform information system analysis and design activities. Therefore, it can be recommended for use in learning.**

***Index Terms*—E-PBL, collaborative, discussion, Collassion Learning.**

I. Introduction

The Indonesian Government, through the Ministry of Education, Culture, Research, and Technology in 2020, established the National Higher Education Standards. Therefore, the learning process is no longer based on lecturers but determined by students, involving the use of various models, such as Problem-Based Learning (PBL). PBL models are used to develop the knowledge and problem-solving skills of students [1] by collaborating in identifying and resolving problems [2]. These models focus on dynamic problems that require the activeness of students in formulating and solving problems based on their knowledge of the content and context. PBL enables students to develop higher-order skills while acquiring knowledge related to their learning by forming research habits through practice and reflection [3]. This model is designed to help students develop thinking, problem-solving, and intellectual skills [4] that utilize a constructivist approach, where they collectively attempt to solve daily problems in a collaborative environment [5]. Small groups are formed to enable students to work together and maximize their learning outcomes [6]. The underlying philosophy is that learning can be considered a constructive, independent, collaborative, and contextual learning activity [7].

Technology has impacted all aspects of life, including education, leading to its application in helping teachers impart concepts, phenomena, and theories. Traditional approaches have been enhanced or replaced by various technologies [8]. Technological developments have enabled teachers and students to access learning materials in various formats without significant time or space constraints [9]. Also, the Industrial Revolution 4.0 promotes changes and the removal of limitations in the different aspects of human life through the support of technological developments and internet networks as the backbone between humans and machines [10].

One of the biggest challenges in the 4.0 industrial revolution era is the development of human resources. This is related to the education sector, which is the most dominant in educating the community to face the challenges of this era [11]. Therefore, creative and innovative processes should be used in teaching students and encouraging their learning [12]. This involves employing easy-to-use tools or media for students [13] and including technology in teaching materials to produce more value. Similar to PBL models, digital technology of e-PaBL (Electronic Problem-Based Learning) can be applied through fully digitized or mixed methods. This will ensure that students attend face-to-face classes as well as communicate and collaborate electronically outside the classroom using digital media that can simplify the process [14]. In addition, e-PBL provides a more flexible and constructivist learning environment, where students can take control of the learning and work with rich and dynamic resources. Students and teachers are freed from the limitations of space and time in the traditional classroom. e-PBL promotes interactions between students and teachers by enabling communication and collaboration inside and outside the classroom [15].

E-PBL contains text-based teaching materials, learning videos, and other resources, such as chat rooms, messaging facilities, discussion forums, and a specifically-created environment for problem-based learning [16]. There are four

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reasons for developing PBLonline applications, namely: to provide support to students, to assist students in developing independence through online systems, to facilitate problem-solving skills, and to build effective online groups.

Consequently, the object of this research was the Information System Analysis and Design course, which is one of the course in the informatics science group that should be taught in research programs with graduate profiles of systems analysts and programmers. The material taught includes the system life cycle with an emphasis on the analysis and system design stages, namely user needs, alongside the system, software, and user screen display design. As much as 75% of the material teaches students to analyze a system to find out its weaknesses and then provide suggestions for improvement in the form of information system design so that the exercises/tasks given must be at level 4 (C4) which is analyzing, level 5 (C5) is evaluating and level 6 (C6) which is creating from the cognitive realm of Bloom's Taxonomy [17], not just memorizing and explaining. The Faculty of Information and Communication Technology, Universitas Teknologi Mataram (Indonesia), offers the learning of Information Systems Analysis and Design with 3 credits, which are equivalent to 150 minutes of face-to-face teaching in class. This involves an explanation by lecturers accompanied by exercises to be performed individually and collaboratively at the end of the semester. However, the learning achievement of the Information Systems Analysis and Design subject in these 2 years is still sub-optimal, as only 62.65% of students have been able to attain at least 70 (B), which is below the target of 80% set by the faculty. Since applying PBL is very suitable and appropriate with the characteristics of the subject, knowing the needs of students regarding the learning model is necessary.

II. Methodology

This research used the Research and Development (R&D) method, which can be used systematically to design new products through various stages. R&D aims to develop or validate educational products and discover practical knowledge [18]. Furthermore, this research was conducted at the Faculty of Information and Communication Technology, Universitas Teknologi Mataram - Indonesia, for 9 months, from April 2021 to January 2022. The stages involved are listed in Table I below:

TABLE I: The Research Stages

No.	Stages	Activity
1.	Field Studies	• Analyzing student needs for the Information Systems Analysis and Design learning model (questionnaire).
2.	Model Development Plan	• Conducting theoretical analysis and preliminary research. • Planning the model design.
3.	Model Development	• Designing the learning model to be developed. • Building applications as a support system. • Developing digital teaching materials. • Validating, evaluating, and revising through expert judgment and testing in three stages, namely one-to-one, small group, and field trials.
4.	Effectiveness Testing	• Testing the effectiveness of the developed learning model.

III. Result

A. Field Studies

Field studies were conducted by distributing questionnaires, which were filled out by 131 students who had taken or were taking the Information Systems Analysis and Design course. The results obtained are as follows:

1) 93% of students often have trouble with assignments related to the analysis and design of information systems.
2) 99% of students want lecturers that can provide direct feedback on their assignments.
3) 88% of students want lecturers that can monitor the discussion process involved in assignments outside the class.
4) 97% of students want learning supported by information and communication technology to promote more effective learning and discussions inside and outside the class.

The questionnaire results describe the learning model required by students, where group assignments and exercises given by lecturers are preferred. Also, they desire the involvement of lecturers during and after the class by involving information and communication technology.

Based on the analysis of students' needs, this research will develop a learning model for the Information System Analysis and Design course with PBL methods supported by technology, known as Electronic Problem-Based Learning (e-PBL). Before implementing the R&D process, the learning products to be developed were described specifically. Then, various types of literature useful in product development were studied by analyzing relevant theories and previous research.

B. Model Development Plan

After the preliminary stage and literature research, the next was development planning. An important factor in the planning stage is estimating the resources required to develop the product. Good planning can help developers avoid wasting work during a defined R&D cycle. The plans made include:

1) Theoretical analysis and preliminary research

Theories of PBL models as well as the analysis results of student needs were a reference in the product development. The product developed was an e-PBL-based Information System Analysis and Design learning model, using support systems, such as learning applications and modules, teaching materials and videos, alongside practice questions based on Higher Other Thinking Skills (HOTS).

2) Research design plan

The research design was used as a guide for performing activities to ensure the stages proceeded in a structured manner, and the allocation of resources needed was made easier. Figure 1 below describes the research design:

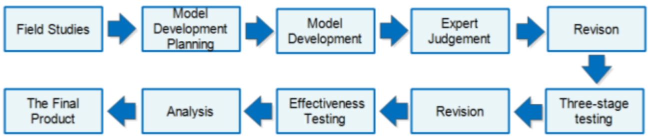

Fig. 1. The research chart.

C. Developed Learning Model

The implementation of the applied PBL model consisted of learning steps (syntax), reaction principles, social systems, and support systems [19]. Then, the syntax was developed based on Syntax Collassion Learning and involved with the following stages:

TABLE II: SYNTAX COLLASSION LEARNING

Syntax Name	*Syntax*
Collassion Learning	1) **Phase 1: Problem Definition** Students attempt the Pre-Test contained in the Collassion Learning App individually. Lecturers provide problems to be solved by students, who are separated into small groups, where each discusses the formulated problems with their basic knowledge and skills. 2) **Phase 2: Independent Learning** Students are expected to actively seek information related to the formulated problems. 3) **Phase 3: Sharing Initial Findings** Students discuss to agree on the solution based on the information obtained. This activity is performed inside and outside the class through discussion forums on the Collassion Learning App. 4) **Phase 4: Group Study** The groups of students discuss the steps to produce solutions that are appropriate to the agreed decisions and evaluate the accuracy of the solutions. Learning in groups is performed inside and outside the class through discussion forums on the Collassion Learning App. 5) **Phase 5: Presentation** Students present the solutions produced by each group to obtain input from other groups and lecturers. 6) **Phase 6: Evaluation** Students and their groups are expected to evaluate the solutions and the steps taken based on input from other students and lecturers. Then, they are to make improvements and submit them to the lecturer through the task submission facility in the Collassion Learning-App within the specified timeframe.

Group work motivates students to listen to each other's opinions and discuss their assignments [6]. As a result, they develop problem-solving skills by formulating ideas, discussing, and receiving direct feedback as well as responding to questions and comments. Moreover, a social system will be formed with lecturers, who function as facilitators that provide direct feedback to students. Feedback from lecturers is very important for students to know their position regarding the achieved learning objectives and the subsequent steps required [20]. In this research, the direct feedback provided by lecturers was about 1) the accuracy of the assignment by giving instructions to obtain more information and 2) the assignment processing related to the potential or applied strategies. These two feedback models are part of the Hattie and Timperley version [20]. Furthermore, a support system, through e-PBL application called the Collassion Learning-App, was needed to enable students to learn and discuss the solution to problems existing in the HOTS-based assignments given without limitations of space and time.

D. Validation, Evaluation, and Revision

A product is considered satisfactory when it meets several criteria, such as high validity, good reliability, and practical value. Therefore, the stages of validation, evaluation, and revision are necessary. The validation exercise in this research was performed on the developed products through testing by experts, who provided suggestions and input to improve and revise the design to obtain a final product appropriate to the needs and related theoretical principles.

1) Expert judgment

Expert judgment was provided to determine the suitability of the product to the research framework. The experts were from instructional design, information technology and learning media, content, language and communication backgrounds, and their input was used as the basis for revising the product. They filled out the provided questionnaires to assess the various aspects of the developed e-PBL model, including its support system, signified by learning modules and the Collassion Learning-App. The results were calculated using a 5-point Likert Scale. Table III shows a recapitulation of the expert evaluation results:

TABLE III: RECAPITULATION OF THE EXPERT EVALUATION RESULTS

No.	*Expert*	*Average Value*
1.	Material content expert	4.651
2.	Language and communication expert	4.36
3.	Instructional design expert	4.58
4.	Information technology and learning media expert	4.833
	Total average score	4.606
	Conclusion	**Very good**

The average value obtained on the scale of 1-5 was 4.606, showing that the resulting product was very efficient.

2) Testing

The product testing was performed in the field by involving students in the three-stage process comprising One-to-One, Small Group, and Field Trials. The students involved in the one-to-one and small group testing had taken the Information System Analysis and Design course and were in semesters 5 and 7. Conversely, those involved in the field testing were semester 3 students who were currently taking the course.

The One-to-One stage was executed by involving three students who had taken the subject, with the criteria of each obtaining an A, B, and C grade, respectively. Students are asked to study the module and try the menus in the Collassion Learning-App within 1 week, then students are asked to conduct an assessment through a questionnaire with 4 aspects of questions, namely material content, language and communication, instructional design, information technology and learning media. There are 31 questions with yes or no answer choices. In addition, students are also asked to provide suggestions or comments by writing them in the column provided. At the end of the questionnaire, students are asked to provide an assessment by putting a checkmark on one of 3 options, namely: feasible for use without revision, feasible for use with revision, or not feasible for use. The three students assessed that the product being tested was feasible for use with revisions. They gave suggestions for improvements to the media aspect. This entailed converting the application operation guide into 2 forms, namely digital books (e-books) and videos, which will be displayed on the application homepage to promote learning. The results of the overall One-to-One evaluation can be seen in Table IV below:

TABLE IV: ONE-TO-ONE EVALUATION RESULTS RECAPITULATION

No.	***Aspect***	***Respondent***
1.	Material Content	100%
2.	Language	100%
3.	Instructional Design	100%
4.	Media and Information Technology	100%
	Total average score	100%
	Conclusion	**Very good**

After this One-to-One stage and the revision of the application according to the suggestions, a small group evaluation was conducted with 9 students. The participants were divided equally into 3 groups of different levels of ability, namely high, average, and low. Students are asked to study the module and try the menus in the collassion learning-app within 1 week, then students are asked to provide an assessment through a questionnaire consisting of 35 questions using a 5-point Likert scale with options: 1-strongly disagree, 2-disagree, 3-undecided, 4-agree, 5-strongly agree. In addition, students are also asked to provide comments or suggestions for improvement in writing in the column provided. At the end of the questionnaire, students are asked to provide an assessment by putting a checkmark on one of 3 options, namely: feasible for use without revision, feasible for use with revision, or not feasible for use. The nine students assessed that the product being tested was feasible for use without revision. Comments given by students stated that the supplement Collassion Learning App had a very good presentation structure, alongside systematic, complete, and user-friendly features. The teaching material presented was clear, easy to understand, interesting, and deserved to be used as learning material, attractive, and neatly arranged. In addition, there were examples of problems and solutions that simplified the learning and practice process. The results of the small group evaluation can be seen in Table V below:

TABLE V. THE RECAPITULATION OF THE SMALL GROUP EVALUATION RESULTS

No.	**Aspect**	**Average Value**
1.	Material Content	4.84
2.	Language	4.59
3.	Instructional Design	4.24
4.	Media and Information Technology	4.189
	Total average score	4.465
	Conclusion	**Very good**

The average value obtained on the scale of 1-5 was 4.465, showing that the resulting product was very efficient and feasible for use. After completing the small group evaluation, the direct learning model was used for field trials with 20 students who had never taken Information Systems Analysis and Design course. Lecturers of the System Analysis and Design course used the learning model and its support system during 1 semester of classes. At the end of the semester, students were asked to provide an assessment through a questionnaire consisting of 37 questions using a 5-point Likert scale with the choices: 1-strongly disagree, 2-disagree, 3-undecided, 4-agree, 5-strongly agree. The results of the field trial evaluation can be seen in Table 6 below:

TABLE VI: RECAPITULATION OF THE FIELD TRIAL EVALUATION RESULTS

No.	***Aspect***	**Average Value**
1.	Material Content	4.583
2.	Language	4.55
3.	Instructional Design	4.617
4.	Media and Information Technology	4.53
	Total average score	**4.57**
	Conclusion	**Very good**

The average value obtained on the scale of 1-5 was 4.57, showing that the resulting product was very efficient and feasible for use.

E. Effectiveness Testing

The effectiveness of the e-PBL model was analyzed by processing the pre-test and post-test data of 20 students generated during the field testing. As shown in Table VII below, the recapitulation of the results indicated an increase in the learning outcomes:

TABLE VII: RECAPITULATION OF THE PRE-TEST AND POST-TEST RESULTS

Respondent	**Pre-test**	**Completeness**	**Post-Test**	**Completeness**
R1	79	Incomplete	95	Complete
R2	68	Incomplete	96	Complete
R3	83	Complete	93	Complete
R4	27	Incomplete	86	Complete
R5	77	Incomplete	79	Incomplete
R6	87	Complete	90	Complete
R7	84	Complete	62	Incomplete
R8	67	Incomplete	91	Complete
R9	59	Incomplete	79	Incomplete
R10	65	Incomplete	91	Complete
R11	53	Incomplete	85	Complete
R12	69	Incomplete	93	Complete
R13	68	Incomplete	94	Complete
R14	92	Complete	99	Complete
R15	84	Complete	97	Complete
R16	78	Incomplete	99	Complete
R17	58	Incomplete	93	Complete
R18	11	Incomplete	89	Complete
R19	76	Incomplete	56	Incomplete
R20	62	Incomplete	88	Complete
Total	**67.35**		**87.75**	
Complete	**25%**		**80%**	

Table VII shows that the average pre-test and post-test values were 67.35 and 87.75 with total completion scores of 25% and 80%. The number of completeness in the post-test reached 80% indicating that the e-PBL learning model developed was proven to be effective in improving student learning outcomes in the Information System Analysis and Design Course. Students are motivated to learn by collaborating with their friends using the Collassion Learning-App which supports collaboration and discussion processes without being limited by space and time as well as the involvement of lecturers in providing direct feedback on the exercises carried out by students, and when students discuss in their groups.

The completeness criteria used are as follows [21]:

X > 80: Very Good
60 < X= 80: Good
40 < X = 60: Good Enough
20 < X = 40: Poor
X = 20: Very Poor

With the following score classification:

X > Xi + 0.6 Sbi →Effective
X = Xi + 0.6 Sbi → Ineffective

The calculations based on criteria and score classifications are presented in Table VIII below:

TABLE VIII: THE EFFECTIVENESS OF THE e-PBL LEARNING MODEL

Respondent	Score	Criteria	Effectiveness
R1	95	Very good	Effective
R2	96	Very good	Effective
R3	93	Very good	Effective
R4	86	Very good	Effective
R5	79	Good	Effective
R6	90	Very good	Effective
R7	62	Good	Effective
R8	91	Very good	Effective
R9	79	Good	Effective
R10	91	Very good	Effective
R11	85	Very good	Effective
R12	93	Very good	Effective
R13	94	Very good	Effective
R14	99	Very good	Effective
R15	97	Very good	Effective
R16	99	Very good	Effective
R17	93	Very good	Effective
R18	89	Very good	Effective
R19	56	Good enough	Ineffective
R20	88	Very good	Effective
Average	**87.75**	**Very Good**	

Maximum Score 99
Minimum Score 0
Xi=1/2 (max+min) Xi 49,5
Sbi=1/6(max-min) Sbi 16,5
Xi + 0,6 Sbi : 59.4 →Effective
Xi - 0,6 Sbi : 39.6 → Ineffective

Table VIII shows that 19 students were effective, leading to the estimation of the model effectiveness to be 95% ((19/20) x 100%). The Information System Design produced an average score of 87.75 with very good and effective criteria.

Subsequently, a significance test was performed using SPSS software to determine the difference in the average pre-test and post-test scores. Based on the analysis, the t-count was -4.024 with a significance of 0.001 and the t-table with N=20 was 3.55181. The lower value of the t-count compared to the t-table value indicates a significant difference in learning outcomes before and after using e-PBL.

IV. DISCUSSION

The effectiveness test showed that the learning model of the e-PBL-based Information System Analysis and Design course was effective in improving student learning outcomes. The Collassion Learning Syntax consists of 6 phases, namely 1) Problem Definition, 2) Independent Learning, 3) Sharing Initial Findings, 4) Group Study, 5) Presentation, and 6) Evaluation. Subsequently, the application of this syntax, alongside reaction principles, social systems, and support systems in creating the Collassion Learning App facilitated an increase in student learning outcomes by 55%, a student average success rate of 87.75, as well as very good and effective criteria.

This agrees with the previous research by Kim et al. (2018) that computer-based guidance in problem-based learning can improve student understanding [22]. Also, Shimizu et al. (2019) showed that PBL reinforced by e-learning is effective in improving students' learning abilities and motivation [23]. Fully digitized or mixed e-PBL methods are more effective than the traditional PBL because of their attractiveness, accessibility, and effectiveness, which can improve communication, collaboration, and independent learning skills [24]. Using Collassion Learning-App as support for e-PBL in this research, students can collaborate and discuss without being limited by space and time. Therefore, collaboration and discussion activities can be performed outside the restrictions of physical classrooms while still receiving directions, feedback, and monitoring from lecturers. These discussions can also be held with friends in the same and different groups, as well as with lecturers, through the facilities provided. The existence of e-modules that are equipped with examples of problems and solutions, teaching videos, and other materials is very helpful for students in independent learning. HOTS-based tasks in each learning activity can promote skills that will increase students' analytical power and ability to produce good information system designs. This corresponds to the research by Bahar, which stated that students need information and communication technology with more features that support learning activities outside the classroom to promote collaboration (groups) and independent learning resources [25].

V. CONCLUSION

The results show that the e-PBL-based Information System Analysis and Design learning model was effective in increasing students' ability to perform information system analysis and design activities. Providing applications that support collaboration and discussion without space and time limitations offers students more time to study with friends in groups and solve problems better. The role of the lecturer as a facilitator that can monitor, provide direct feedback, and be involved in discussions held by students even after class hours is an added value that enhances the motivation to study this course. Therefore, the e-PBL model with support systems, namely an application that facilitates collaboration and group discussion, can be recommended for use in learning, including other disciplines with similar characteristics to the Information Systems Analysis and Design course.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

Author Contributions

Dwinita Arwidiyarti developed the main idea of the study, conducted data analysis, and designed the test. Meanwhile, Khaerudin contributed to developing learning models, and Basuki Wibawa contributed to developing electronic problem-based learning.

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