Application of problem-based learning assisted intelligent learning media to improve the cognitive aspects of students

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Abstract. Problem Solving is one of the capabilities that must be possessed by students in the department of Software Engineering, this ability is directly proportional to the cognitive abilities possessed by learners. Problem Based Learning Method (PBL) is a proven learning method in improving problem solving ability of learners. To determine the effect of PBL on students majoring in Software Engineering, conducted research on students, using the PBL method that is assisted with learning media. Learners are divided into groups to be given a 'problem' to be solved by each group. Educators can provide educators questions that lead to the solution of problems given to learners in the form of materials, scripts or in other forms of learning media. Learning media made with Intelligent Tutoring System (ITS) where this media can guide learners in depth of certain material that has not been mastered. This can be seen from giving media suggestions to learners after doing pretest or posttest. The results of this study can be quite successful with an increase in the gain index of 0.36 that can be categorized as a moderate increase.

1. Introduction
Education is an important factor in creating quality human resources. Education provides insights into life to become a perfect human being. Because the purpose of education itself is humanizing humanity. Education in general means any conscious effort planned to influence other people, individuals, groups or communities so that they do what the educator wishes to do [1].

The advancement of science and technology today is very useful in many areas of life. Especially information technology is very influential on the field of education. Implementation in the field of education is very influential in the preparation and implementation of learning strategies. Through these advances the Educators can use various media in accordance with the needs and objectives of learning. The learning objectives of the Student are the achievement of optimal development, covering the cognitive, affective and psychomotor aspects. While the objective of the curriculum is the fulfillment of all target goals in written documents to achieve the learning objectives based on the stages set [2].

Along with the development of education at this time becomes a challenge in providing the media of learning. The right choice of instructional media is a systematic sequence of qualitative processes based on general principles of learning [3]. Media plays an important role in student education designed to improve students' knowledge in the learning process. The use of media is also designed to create a more attractive and effective learning environment [4-7].

As contained in the purpose of learning so that learning can improve the congetive, affective and psychomotor aspects of learners. The learning process must lead the students to master these three aspects. In the cognitive aspects of learning can be designed to form cognitive abilities by emphasizing
the improvement of intellectual ability and understanding of learners of the material given to the learning process.

Learning media is a medium used in learning, which includes teacher aids in teaching as well as a means of carrying messages from learning resources to the recipient of learning messages [8]. As a presenter and channel of messages, media learning in certain matters can represent educators in presenting learning information to learners. If the instructional media is designed and developed properly, then the media function can act as a substitute for students when unable to attend.

Intelligent Tutoring Systems (ITS) is a computer program designed to present effective and adaptive learning and to assist educators in evaluating the thinking process of learners to determine the type of assistance needed. The tutor should be able to define and evaluate every action the learner has taken. In addition to evaluating learners, intelligent tutors can also suggest subsequent actions [9]. With the many applications of ITS to the learning media that will be discussed in the next chapter of this study, we design and implement ITS on web-based learning media to improve students' understanding of the material of branching algorithms.

ITS learning media that we proposed aimed at educators and learners with different roles. With educators who can manage the content, users as well as the work of learners and see the improvement experienced by learners, but learners can only access the content, work and manage their profile. The main purpose of our system is to present the subject matter and tests that will determine the level of students' understanding of the material presented, and the educator can determine the improvement of students' understanding. E-learning is an educational system that is available anytime and anywhere if people have their own computers. In an effort to realize an e-learning system without a human tutor, the agent's tutor will check the learner's answers and provide the advice necessary to replace the human tutor [10].

Learning media created as a learning aid in the subtopic metrics point function in software engineering courses. Intelligent components in this system exist in the ability to adapt the knowledge and needs of each user. Thus, this adaptation is made by modeling knowledge from educators and learners. An important part of this system is the interface that allows for added knowledge into the system [11]. TIPOO (Inteligente Tutorial la la Programacion Orientada a Objetos) was born on the initiative to support the Object Oriented Programming (OOP) course, which is part of the curriculum in software engineering majors at the Spanish university. TIPOO is an ITS that adapts the features of several systems such as the types of learning materials (video, documents, PPT, Games and others), level of learning materials (Low, Intermediate, Advanced), TIPOO is also able to track some user elements, dominant, interaction time with the system, the number of exercises solved, the test scores, among each other [12]. GITS (Game-based Intelligent Tutoring System) was developed with the aim of developing the ability to solve problems from novice web programmers as well as to learn the basic capabilities of computer programming. Using GITS, learners will have support in the fundamental concepts of computer programming, improving web-based problem-solving skills and improving their motivation [13].

2. Methods

2.1. Research Design
The design of One Group Pretest-Posttest research has various stages: Pretest, Treatment Stages, and Posttest. With the results of the treatment that can be known from Posttest done, we can compare it with the result of Pretest which was already before the treatment was given. The research pattern on One Group Pretest-Posttest can be seen in Table 1.
### Table 1. Pretest-Posttest One Group Research Pattern.

|               | Pretest | Treatment | Posttest |
|---------------|---------|-----------|----------|
| \(0_i\)      |         | \(X\)     | \(0_2\)  |

Explanation:
- \(0_i\) = Pretest
- \(0_2\) = Posttest
- \(X\) = Treatment, application of Problem Based Learning method with Intelligent Learning Media

2.1.1. Location and Subject Research. The study of learning media development is done in vocational high school in West Bandung regency, namely in SMK Bina Wisata Lembang more precisely in the Department of Software Engineering. The location of this study was chosen based on knowledge and experience of the informants / related to the implementation of education policy and the system that ensures the internal quality of the site, and consider the accessibility of accessibility and some other considerations.

The selected subject is the student of the vocational school. Subjects were selected based on snowball techniques, which gave authority to researchers in determining research subjects based on data source search results tailored to the needs of the study.

2.1.2. Development of Research Instruments

- **Field Study Instrument**
  Field studies conducted in the form of surveys to determine what needs are felt required. Then the results of the survey were made a general analysis for the development of instructional media.

- **Media Assessment Instruments by Experts and Student Responses**
  The media expert assessment instrument in the form of a structured questionnaire is sourced from: Caroline McCullen, et al (http://www.sasinschool.com/). Assessment instruments are conducted to view media feasibility in terms of content, presentation, language and kegrafikan. Instrument penilaian student responses conducted to see responses and assessments of students about learning media developed. Data obtained through questionnaires were analyzed using descriptive analysis techniques described narratively.

2.1.3. Data Analysis. After the data from the data collection instrument is obtained, the next step is to process and analyze the data. This research performs analysis of qualitative descriptive and quantitative descriptive statistic. The steps of data analysis are as follows:

- **Data Analysis Field study**
  Field study conducted in the form of non-participant observation, then the results of observations that have been done can be directly described.

- **Analysis of Media Evaluation Data by Expert and Student Response**
  Data obtained through questionnaires were analyzed using descriptive analysis techniques described narratively. Data processing is done by using descriptive technique percentage with the following formula:

\[
p = \frac{\text{Total score of data collecting result}}{\text{Number of criteria scores}} \times 100\%
\]

Explanation:
- \(p\) : Percentage of media eligibility
- Criteria Scores : The highest score of each item x number of grains x the number of respondents

2.2. Tests Analysis of Student Learning Results

To know the learning outcomes by applying ITS learning media, then the calculation of the value of gain. Normalized Gain can be calculated using the following formula [14]:

\[
\]
Explanation:
\[ <g> = \frac{T_2 - T_1}{Sm - T_1} \]  

\((2)\)

Table 2. Normalization Gain Criteria.

| Boundary | Category |
|----------|----------|
| \( g > 0.7 \) | High |
| \( 0.3 \leq g \leq 0.7 \) | Medium |
| \( g < 0.3 \) | Low |

3. Results And Discussions

3.1. Design and Creation of ITS Learning Media

ITS Learning media development happens in several stages: analysis, design, development, implementation, and the assessment stages [15].

3.1.1. Needs Analysis. Stage analysis is done to review the needs of what it deems necessary to be a product in this study. ITS learning media is designed based on the results of observations and interviews conducted with teachers of basic programming subjects in Bina Wisata Lembang Vocational School expertise program. This media is expected to meet the needs of learners and educators as education practitioners, which helps in conveying the material in question.

3.1.2. Media Design. At this stage media design is based on the results of the analysis obtained, designing the appropriate lesson plan, and branching material developed into 4 sub-chapters and each sub-chapter is divided into 3 more topics. The sub-chapters here are, branching If, If-Else, Nested If, and Case. The topics of each sub-chapter are definitions / theories, the application of theory into system and programming logic.

3.1.3. Development. Learning media development stage is used a simple tracking method, where all the answers that learners do when doing a matter of pretest and posttest taken for later educators see and draw conclusions on the development of all learners that exist in the class.

A simplified tracking method of the tracking algorithm presented by [16] where he proposes tracking algorithm for many targets, whereas in this learning media, the target is seen only the answers of all learners. Tracking itself researchers take for learning media can facilitate educators in determining how much improvement of cognitive aspects of learners. This is done so that educators can prepare strategies and supporting materials that will be discussed in the next learning activities.

Figure 1. Display of ITS Learning Media.
There are two types of users in this media, i.e., learners and educators. Learners on this system can only access the materials, questions, exercises, and profile management and see the results/grades of the tests that have been done by the learners and advice on the lack of understanding of learners on certain materials. While educators can access the test results of learners, add teaching materials, add test questions, and add training materials for learners and can see the development level of understanding of learners of learning materials.

This medium can show the material/test which should be the learner to finish. If one of the materials/tests has been completed and meets the minimum criteria value of this media, the material/test will be removed from the learner's choice. And the material/test that has not met the learner's criteria value and has not fulfilled the requirement to study the material/test, the learner cannot access it except to finish the first material/test which becomes its precondition, this is done so that the learner can comprehend all the material in sequence and avoid misconceptions of learners.

In addition, learners who have completed submission of the concept on the event will be given access to the material and the next posttest, in accordance with the results of the previous submitter. Here is a picture of the proposal from the media learning.

![Figure 2. Display of Proposed Media Learning.](image)

In the picture above, the material/tests that have been completed can not be seen again, this is because the media assume that learners already understand the material, therefore the media eliminate the material/tests about submateri who have mastered the learners.

Educators have an obligation on every learner who is responsible for the learning activities done, therefore educators have an obligation to know the level of understanding of each learner who has become its responsibility. Therefore, this intelligent learning media is created to help educators understand the level of understanding of each learner who is under his responsibility.

3.1.4. Implementation. Learning media that have been made implemented as a medium of basic programming instruction in class X skill program in Bina Wisata Lembang Vocational High School. The class chosen as research object is class X.

3.1.5. Evaluation. Evaluation is done to process the data that has been obtained and review each phase is done correct, then done final revision in accordance with evaluation results or needs that can not be met by the media.

3.2. Data Analysis Research

3.2.1. Assessment of Media Experts and Learners. At this stage, the researchers used questionnaires to obtain validation from media experts and material experts, the overall multimedia used in this study has been very good, this is proved by the percentage of feasibility gained from media experts by 80%. After getting the results, then the multimedia can be used in the test phase.

Assessment of learners to the learning media will be used as a reference in the process of improving learning media. Learning media created must be in accordance with the needs of learners who are the main target as media users. Media users are class X students of Software Engineering skill program as
many as 39 people, all students who have done learning and using media. Assessment of learners was taken from the questionnaire conducted by questionnaire number of 20 items. The average results of the students' assessment of the media by 78% in the category worthy of use. This feasibility comprises conformity with basic programming learning and material accuracy.

3.2.2. Test Results Learning. Learning outcomes from the application of this media ditujukkan to determine the increase in the cognitive sphere (understanding) of students to the material presented by the learning media ITS.

Assessment of learning outcomes of learners after using ITS learning media can be seen from the result of increasing the average score of pretest, posttest and N-gain presented in the following table:

| Group | Information     | Pretest | Posttest | Gain |
|-------|-----------------|---------|----------|------|
| High  | Maximum Value   | 85      | 85       | 0.33 |
|       | Minimum Value   | 70      | 80       | 0.00 |
|       | Average         | 78.18   | 83.18    | 0.22 |
|       | Number of Data  |         | 11       |      |
| Middle| Maximum Value   | 75      | 80       | 0.60 |
|       | Minimum Value   | 45      | 65       | 0.00 |
|       | Average         | 58.64   | 75.91    | 0.40 |
|       | Number of Data  |         | 22       |      |
| Low   | Maximum Value   | 60      | 80       | 0.60 |
|       | Minimum Value   | 40      | 75       | 0.25 |
|       | Average         | 50.83   | 75.83    | 0.46 |
|       | Number of Data  |         | 6        |      |

Average Gain Entirely 0.36

Table 3 illustrates the average N-gain value of 0.36, indicating that the N-gain value is in the moderate category, where $0.3 \leq g \leq 0.7$. This shows that learning activities using learning media ITS is an effective learning because it can improve learning outcomes of learners.

4. Conclusion
Based on the observation, processing and data analysis that has been done, the conclusion obtained from the results of this research process is: 1). ITS learning media is a tool in the learning process used to improve students' understanding of basic programming materials; 2). The comprehension ability of learners increases as can be seen by comparing the average value of pretest originally valued 63, when the posttest is done the average value rises to 78, with an N-gain value of 0.36; 3). Most learners assess ITS learning media is very helpful in the course of learning activities, it is very visible when educators are unable to attend in the learning activities.

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