Increase the problem solving ability through improved prior knowledge

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Abstract This study examines the contribution of prior knowledge to improving problem-solving in learning using interactive multimedia. This research is an experimental quantitative study with a sample of 38 people. The implementation process begins with giving a pretest, giving material by the researcher, practicing by the participants using an EMS (engine management system), and ending with providing a post-test. The research uses EMS as a result of the development of existing media on campus. Analysis of research data is using an independent sample t-test. The work shows that there is a significant contribution of prior knowledge to problem-solving. This study shows that prior knowledge is essential to increase problem-solving abilities. Prior knowledge is the overall competence of students as a result of learning activities before following the next learning process.

1. Introduction

There are two groups of jobs in the automotive sector, namely: (1) projects, for example, requests for modifications; (2) a problem, for example, a customer comes to the repair shop and tells about his car complaints, this condition is a problem. Technicians need knowledge to solve problems. Technicians acquire knowledge from school or work experience. Technicians will find it easier to understand this knowledge and experience if they have basic knowledge or are more popular with prior knowledge. The education and training center (Pusdiklat) of Suzuki in the State University of Malang as a training institute for prospective technicians will work in Suzuki workshops, and several workshops throughout Indonesia require to master prior knowledge and problem-solving skills. Prior knowledge of students at the Pusdiklat is still in the low category, apart from the lack of prior knowledge. Their problem-solving abilities are also in the same category as prior knowledge.

Experts interpret much Prior knowledge. Hailikari et al. [1] state that prior knowledge is the mastery of students' knowledge to obtain new knowledge that is relevant to the mastery of prior knowledge. Dierking [2] states that prior knowledge is the knowledge of students, both subject knowledge, strategy knowledge, and personal knowledge when learning new material. Song et al. [3] define prior knowledge as a basic map of learning. Prior knowledge has several characteristics: (1) consisting of declarative and procedural knowledge; (2) presenting before the implementation of specific learning tasks; (3) is available or can be recalled or reconstructed; (4) relevant to the achievement of learning task objectives; (4) arranged in a structured scheme; (5) to some degree transferable or applied to other study tasks; (6) is dynamic. Prior knowledge is the overall competence of students as a result of learning activities before following the next learning process [4]. Prior knowledge is a significant component in learning [5],[6],[7]. Prior knowledge is the overall acquisition of knowledge, attitudes, and skills of students’
results of learning activities before following the next learning process [4]. Prior knowledge helps in forming hierarchical knowledge [8]. Prior knowledge is the overall competence of students as a result of learning activities before following the next learning process [4]. Prior knowledge is a significant component in learning [5],[6],[7]. Prior knowledge is the overall acquisition of knowledge, attitudes, and skills of students' results of learning activities before following the next learning process [4]. Prior knowledge helps in forming hierarchical knowledge [8].

There are two factors in improving prior knowledge, namely, internal and external [9]. A technician can apply Prior knowledge thoroughly to improve individual abilities [10]. Thus, prior knowledge is useful to avoid misinterpretation [11]. Then, students who have high prior knowledge have the advantage of obtaining new information [12]. Prior knowledge can determine how well students obtain information [13]. Prior knowledge helps in forming hierarchical knowledge [8]. Mastery of students' prior knowledge is essential because it allows overcoming cognitive demands [5]. Prior knowledge in this study focuses on the ability to read electrical wiring. The ability to read electricity is the basis for every process in the automotive sector, for example, the Antilock brake system (ABS), if there is a problem with the system, the technician must master the electrical wiring of the ABS. A technician who has prior knowledge will find it easier to solve problems in the automotive field. So, students go through the process of problem-solving activities or problem-solving.

Some experts define problem-solving with various meanings. Problem-solving is a sequence of thought patterns in solving problems [14]. Problem-solving is an activity that uses high-order thinking [15]. Problem-solving skill is highly valued [16]. Aulbur [17] in an article entitled "Skill Development for Industry 4.0." states that the problem-solving ability industrial 4.0 era. Every problem solving requires knowledge [18],[19]. The problem-solving process requires both long-term and short-term memory [16]. Wallas [20] explains that the problem-solving stages include: (a) preparation, (b) incubation, (c) lighting, and (d) verification. Problem-solving is the primary key in the field of science [21]. In this study, problem-solving focuses on the ability to solve electrical problems in the EFI (electronic fuel injection) system. The relationship between prior knowledge in the automotive field is very close. Thus, these two components are of concern in automotive education. To improve this ability, researchers used problem-based methods and learning based on a multimedia interactive engine management system onboard. Some researchers agree that teaching with problem-solving methods is more efficient [22],[23]. The problem-solving stage has several stages, namely: (1) reduction; (2) Reversibility; (3) Managing various aspects; (4) Changes in aspects; and (5) Transferring [24]. Problem-based learning will be more effective if it uses the right media. This study uses comprehensive interactive multimedia. Multimedia is the integration of various media to enrich the delivery of messages [25]. Multimedia is a vehicle to reduce cognitive load and reduce instructional guidance. Mayer [26] states that multimedia have provided many benefits for learning opportunities that are 56% greater. Learning consistency is 50-60% better, and content retention is 25-50% higher.

Yang [27] states that prior knowledge is a critical element in the problem-solving process. Prior knowledge influences the use of strategy choices for problem-solving actions. A problem-solving solver must determine and solve a problem according to previous experience [23]. Researchers found a significant contribution of prior knowledge to problem-solving in learning using interactive multimedia. This study uses interactive multimedia that consists of many components that can display images and can be simulated. simulation is one way of providing understanding. This research is still not perfect so it needs improvement, especially on media that is still in the form of objects, not in the form of software.

2. Method

Participants: This research is the implementation of interactive multimedia in the automotive program at Malang State University. The sample in this study is 38 students in the automotive training program. Each participant has prior knowledge, namely the ability to read electrical system images. The researcher chose to read electrical wiring as prior knowledge because reading electrical wiring is the basis for the next material. In this study, the electrical wiring is displayed in the engine management system media.

Instruments: Prior knowledge and problem-solving in this study were measured using a multiple-choice pretest and posttest. Prior knowledge and problem-solving in this study were measured using a
multiple-choice pretest and posttest. Pretest to measure the prior knowledge that students have mastered after taking the machine control course. Posttest is a researcher's effort to measure the impact of the engine management system implementation.

**Materials:** This research is an engine management system implementation in an automotive training program.

**Interactive multimedia specifications** consist of 1) completeness of the engine management system electrical wiring; 2) completeness of monitor voltage and resistance; 3) sensor and actuator simulation buttons; 4) complete layout plans for sensors and actuators; 5) completeness of component names; 6) completeness of the location of the components in the vehicle; 7) completeness of ignition simulation; 8) completeness of fuel system simulation; 9) completeness of the combination meter; 10) completeness with relays; 11) completeness with fuse; 12) complete laptop/scan tool / pc; 13) complete with LCD screen/projector.

**Procedure:** the stages of the research procedure as in Figure 2

**Figure 1. Interactive multimedia**

**Figure 2. Implementation flow**

There are several implementation flow processes. (1) The researcher or facilitator demonstrates interactive multimedia. (2) The facilitator forms small groups with the number of members of the study team and the number of participants according to the population. (3) The facilitator distributes the necessities to each group to practice following the material
delivered by the facilitator. (4) Each group is responsible for its group. (5) The facilitator makes observations during the practical process. (6) Students in groups carry out experimental/experimental activities following the material delivery by the facilitator. (7) Each participant fills out a job sheet during the activity practice. (8) Each group, in turn, has the opportunity to present the results of their experiments/experiments. Other groups provide input and feedback. The facilitator provides input about the incorrect answers from each group; the facilitator does not portray themselves as a source. (9) The facilitator ends learning by doing post-test activities; (10) Post-test data analysis using an independent sample t-test. (11) Interpretation is the result of quantitative data analysis.

3. Research results and discussion

Prior knowledge is a comprehensive applicative to improve individual abilities in specific fields [10]. Students must master Prior knowledge as a basic scheme in learning [3]. Prior knowledge influences learning activities to be a concern [6]. Prior knowledge helps in forming knowledge hierarchies. The problem-solving ability has a significant role in the prior knowledge process [8]. Prior knowledge and problem-solving have increased with the use of interactive multimedia due to the increasing need for interactive multimedia in conveying information [28],[29],[30]. Problem-solving is an activity that uses high-order thinking. Prior knowledge is an essential component in learning to influence problem-solving [31]. This study describes the appropriate value in table 1 with a significance of 0.14, which is smaller than 0.05. That is, prior knowledge contributes to problem-solving. The contribution of prior knowledge is 15.79% according to table 1.

| Table 1. Coefficients |
|------------------------|
| Model | Unstandardized Coefficients | Standardized Coefficients |
|       | B | Std. Error | Beta | T | Sig. |
| 1 (Constant) | 16,835 | 15,918 | 1,058 | .297 |
| Prior knowledge | .489 | .189 | .397 | 2,595 | .014 |

Prior knowledge is the knowledge of students, both subject knowledge, strategy knowledge, and personal knowledge when learning new material. Prior knowledge with instructional strengthening can improve students' abilities [32][33]. Problem-solving is the primary key in the field of science [21]. So, every student must master it. The level of knowledge of students affects problem-solving abilities. Yang [27] states that increasing problem solving is in line with the increase in prior knowledge. Problem-solving is the primary key in the field of science [21]. So, every educational program needs to pay attention to these abilities. Teaching problem solving is efficient [22],[23]. Efforts to improve problem-solving are significant by using the right method and the right media too. Multimedia is a vehicle to reduce cognitive load and reduce instructional guidance. Mayer [26] states that multimedia have provided many benefits for learning opportunities that are 56% greater. Learning consistency is 50-60% better, and content retention is 25-50% higher. Other studies also explain that the use of multimedia has provided advantages compared to conventional learning (learning without using multimedia) [34].

| Table 2. ANOVA |
|----------------|
| Model | Sum of Squares | Df | Mean Square | F | Sig. |
| 1 Regression | 866,853 | 1 | 866,853 | 6,735 | .014a |
| Residual | 463,348 | 36 | 128,708 |  |  |
| Total | 5500,342 | 37 |  |  |  |

a. Predictors: (Constant), prior knowledge
b. Dependent Variable: problem-solving
Table 2 shows the test for the prior knowledge group and the problem-solving group for the F test of 6.735, with a significance of 0.14. The significance is less than 0.05. The prior knowledge group has a significant effect on problem-solving abilities. Many types of multimedia applications take advantage of interactive multimedia technology. Interactive multimedia is useful for describing areas of scientific research that support expression or communication through various media. The use of the word interactive means that multimedia interact with their users. There is support from scientific learning designs. The use of interactive multimedia has existed since technology and informatics appeared. Hopefully, the quality of learning will be better by using multimedia.

Every problem solver must determine the necessary knowledge (prior knowledge) when solving problems [23]. Table 2 shows the significance of 0.014. That is, table 2 shows that the t-test coefficient is statistically smaller than 0.05. That is, prior knowledge contributes to problem-solving. The results are in line with Ionas et al., research [35] which states that prior knowledge contributes to the effectiveness of problem-solving. The point that prior knowledge is the key to improving problem-solving ability. Concrete action to improve the prior knowledge is to use a media that can help learners to illustrate the material presented.

4. Conclusion
There is a significant contribution of prior knowledge to problem-solving in learning using interactive multimedia. Prior knowledge is a basic scheme when taking the next learning process. Problem-solving, which is a high-level thinking process, requires basic knowledge in every process.

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