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Development of a Model for Automotive Vocational Education (AVE) Learning in Technical and Vocational Education Training

Hasan Maksum[a*], **Wawan Purwanto**[b], [a,b]Engineering Department, Universitas Negeri Padang, Email: [a*]hasan_maksum@yahoo.co.id

The choice of learning model has an essential role in increasing student competency. In this study, the learning model was developed from the integration of Problem Based Learning (PBL) with Project Based Learning (PjBL), based on problems as a starting point for gaining new knowledge. The development process of the PBL Model was adapted from Torp & Sage (2002) and the development of the PjBL Model refers to the work of Lucas (2008). The validity of the model using expert testing through Focus Group Discussion (FGD) was tested in this study. To assess the model, a research and development method was applied. Validity construct analysis using the LISREL 8.51 was conducted followed by effectiveness testing through quasi experimental design using a non-equivalent control group. In its application, the model generate ten syntaxes: identification of problems, defining problems, accumulation and selecting of information, solution collection and selection, project planning, project schedule design, presentation of the best solutions for the problem, work on project assignments, evaluation of project results and evaluation of the learning process. The results of this study are that for students majoring in automotive studies, this method improves learning outcomes in terms of communication skills, commitment, confidence, responsibility, ability to solve problems, and ability to work together.

Key words: *Vocational education model in otomotive, Project based learning, Problem based learning, Teching method, Focus group discussion.*

Introduction

The Vision and Strategy of Educational Development in Indonesia in 2020, is focused on the quality of human resources. Depdiknas (1996) outlines four basic national strategies: (1) equal opportunity, (2) relevance, (3) quality and (4) efficiency. Educational results are considered a component of human resource quality, where the product has the following characteristics: (1) students show a high level of mastery of the requisite learning tasks including academic learning outcomes expressed in learning achievement, (2) the learning experience is in accordance with the student functional knowledge needs for life, in terms of practical application not just theory such that students not only "know" something but "can do something" and (3) learning experiences are in accordance with the demands of the workforce. From this point of view, relevance is one aspect or indicator of the quality of learning (Depdiknas, 1996).

Steering, Brake and Suspension system courses are one of the Work Skills Courses offered in the Automotive Engineering Department. This subject is one of the main courses and is mandatory. This subject is often considered a difficult subject in terms of memorization because it uses many concepts and terms in complicated foreign languages that must be committed to memory. This perception needs to be changed gradually because learning by memorization is not profitable (Asubel, 2007). Further, memorizing information is a tedious activity and information that is memorized, but not used, quickly disappears and is forgotten. For this reason, assignments, projects and learning are programmed into learning so that responses to the tasks completed are learnt through practice (Marcelinus, 2019).

The results of a review of 30 Automotive Engineering students in the July-December program showed that students rated the frequency of lecture methods used by teachers as a learning method in the Automotive Engineering Department at 70 percent. In addition, 65 percent of students stated that the learning in the Steering, Brake and Suspension subjects became less attractive and did not lead them to think critically because it was still dominated by traditional learning models and was teacher centered. This fact is reinforced by Chen (2008) who states that most students experience limitations in problem solving, largely due to didactic factors, including teaching-centered learning models. Furthermore, Trianto (2009) adds, the education system in Indonesia generally still applies a one-way pattern, so this learning tends to be dogmatic with memorizing dominant and subsequently student creativity and critical thinking is reduced. Learning models that are centered on lecturers or teachers tend to fail in developing various skills such as the ability to solve problems, the ability to think critically, the ability to communicate, and the ability to cooperate (Chen, 2008; Emil and A.M. Muad, 2018).

Previous research reveal that learning outcomes are correlated to the information obtained via learning activity (Mossuto, 2009). Kardi & Nur (2000) affirm that the weaknesses in the learning process include lecturer centered pedagogy, shortcomings in learning variation, limited differentiation, evaluation methods that merely test memory and deficits in learning strategies. Furthermore, Mossuto (2009) argues that the characteristics of learning show a damaged educational experience and there have been layers of irregular experience.

The efforts to improve learning activities in the steering, brake and suspension subjects delivered are focused on efforts to develop the problem project based learning model, a learning model developed from two initial models, the problem based learning (PBL) model and the project model based learning (PjBL). Development of learning models in the automotive department is needed to synergize the benefits of the PBL model with the PjBL model in learning. Lyda & Megan (2002) revealed that PBL has essential steps including: (1) developing problem-solving expertise, (2) creating self-directed learning, (3) procuring coordinate data, (4) guaranteeing a learner-centred approach, and (5) collaborating. The focal points of PjBL (Moursund, 2016) are that it is: "learner centered and inherently spurring, empowers collaboration and agreeable learning, permits understudies to form incremental and ceaseless change in their items, introductions, or exhibitions". By synergizing the strengths of the two learning models, it is expected that creative problem solving will result in bridging the gap between the actual conditions and the optimal conditions expected in student learning outcomes (Helmiati et al. 2019).

In this research a PBL Model Development for learning steering, brake, and suspension system subjects in automotive vocational education was investigated in reference to the PBL of Torp & Sage (2002) model with a syntax consisting of 8 steps: (1) meet the problem, (2) understand the problem, (3) define the problem statement, (4) gather and share the information, (5) generate possible solutions, (6) determine the best fit of solutions, (7) present the solution and (8) debrief of the problem.

Furthermore, the development of the PjBL model for Automotive Vocational Learning at Padang State University refers to the PjBL model developed by Lucas (2005) with a syntax consisting of 6 steps: (1) begin with the essential question; (2) design a plan for the project; (3) create a schedule; (4) monitor the student and the progress of the project; (5) assess the outcome; and (6) evaluate the experience. The reason for choosing this model as a pilot was because based on available references, this model is the latest PBL and PjBL model, suitable for adult education. The purpose of this research then is to develop a problem-project based learning model that can be implemented in the steering, brake and suspension learning model in AVE at Universitas Negeri Padang. The PjBL learning model can potentially develop such varied affective domain skills and abilities as academic achievement, problem solving skills, discipline, communication skills, confidence, interest in learning, commitment, and the ability to work together.

Research methodology

Research and development (R&D) was conducted in this study. Soenarto (2012) argues that R&D has four basic tenets; (1) commitment to quality improvement (having a commitment to make improvements and continually improve the quality of the learning process), (2) work integration in models, systems, or tools that are developed as an integral part of the learning process, (3) scientific endeavour where development models, systems or tools of the learning process are carried out through the stages and flow of scientific methods, and (4) consistency, demonstrated through a consistent attitude and care in an effort to improve the quality of the learning process.

The development procedure used in this study was adapted from the Barrows (1996) model. There are five steps to developing the model: (1) preliminary research, (2) developing and designing initial products, (3) expert validation and revision, (4) model testing and evaluation, and (5) final model stages and reports. The validity of the model was determined using expert testing through Focus Group Discussion (FGD). Testing of the effectiveness was achieved through quasi-experimental design by using a non-equivalent control group design. The level of effectiveness was measured by increasing learning outcomes (cognitive, affective and psychomotor).

Results and discussion

This research produces an AVE model and in the process of creating a valid learning model, the development stage is based on the components of the learning model. Rusman (2012: 136) explained that the components of the learning model consist of syntax, social systems, reaction principles and support systems. So, in the development of AVE learning models in this study there are four components. Based on the results of the validity test conducted, it can be concluded that the theoretical model of AVE learning developed is valid on all four components of the learning model.

Previous research analysis

In the context of developing learning models, Meyers et al. (2013) define need assessment as: the method by which one characterizes instructive needs and chooses what these needs are. This opinion was strengthened by Joyce et.al, (2003) who opined the notion of need assessment which implies in the purpose for gathering data almost errors and for utilizing that data to create choices aproximately needs. Need Assessment is a way or method to find out the difference between the desired conditions and the conditions that should be expected with existing conditions.

Based on the results of preliminary research, it was concluded that the learning process in the Steering System, Brake and Suspension Courses was not yet effective. The results of the needs analysis show that the level of achievement of vocational student competencies in Diploma III in Automotive Engineering is based on student opinion, which is still at a sufficient level. Even if analyzed based on a questionnaire, there is a large competency gap between the current conditions and the conditions of expectation, which is 24.8% in the opinion of students and in the opinion of graduates.

The high gap in competence between current conditions and expected conditions is due to the development of automotive technology which is not matched by the readiness of resources in the Automotive Engineering Department. As found, during the last three decades the development of automotive technology has been exponential. Technology that was once considered modern is quite possible today stale. Electronic Fuel Injection (EFI) technology is a case in point, for example until recently, the Electronic Control Unit (ECU) which had limited electronic sensor variable capability was used but his has now been refined with Electronic Control Timing Variable Valve (VVTEC), Electronic Squental Port Fuel Injection (ESPFI), and Electronic Throttle Control (ETC). A further example is the chassis system of a car, previously a centrifugal type automatic transmission was used but this has since been refined to Continously Variable Transmission (CVT) automatic transmission.

Typically, in the current learning process, students tend to be passive, waiting for explanations and answers from lecturers. Lecturers are still the center of the learning process and students should be more active than lecturers, students must be active and independent, engaging in student-centered learning patterns. The PjBL model is considered suitable to be applied in AVE as it is expected to be able to increase the competence of students and graduates through problem-based learning. In this case, the students learn to explore wider automotive information from various sources.

Product development process

The AVE learning model needs to pay attention to content development. Aspects of content developed must refer to guidelines for the development of teaching materials from the Ministry of National Education. The principles of developing teaching materials are: (a) start from concrete and move to abstract, (b) present appropriately and using variety, (c) motivate students to learn, (d) contain indicators of achievement, and (e) pay attention to the diversity of student abilities (Depdiknas, 2008). Therefore, in developing valid learning content, the development must pay attention to aspects of the quality of the content and quality of learning.

Another crucial component in the development phase of the AVE learning model is the presentation of the model. This presentation was assessed from the aspect of the use of language and sentences by the lecturer and in student manuals. In this presentation, communicative language is needed so that it is easily understood by students. The use of sentences in the presentation of the model should also pay attention to the rules of writing. Based on the results of the validity test by experts, it can be concluded that the presentation of the model developed in the AVE learning model is included in the valid category.

The lecturer guidance component consists of AVE implementation guidelines, learning program plans, and learning evaluation instruments which are important components in developing AVE learning models. The syllabus is a plan prepared as a guideline for the implementation of learning activities. Syllabus validation is carried out on aspects of syllabus components, aspects of syllabus contents and languages. Based on Permendiknas No. 41 of 2007, the components that must be contained in a learning program plan are: identity, competency standards (learning outcomes), indicators of competency achievement (soft skills), learning objectives, teaching materials, time allocation, learning methods, learning activities, assessment of results learning, and learning resources. The results of the data analysis of the syllabus component validation by the validator showed that all syllabus components developed were in accordance with the standard components stipulated by the Ministry of Education and it can be concluded that the learning model syllabus is in the valid category.

AVE validation model

The validity of a learning model in research and development is absolutely proven which shows that the learning model developed is fixed and appropriate for application in student learning in the Department of Automotive Engineering FT UNP. A valid statement was given by 5 experts with relevant fields to assess content validity and 18 experts with relevant fields to assess construct validity, by providing assessments through valid and reliable instruments. The analysis showed that the average value of Aiken's V obtained was 0.947, with Aiken's V rating range ranging from 0 to 1. According to Saefuddin (2014) that the criteria for the validity level of Aiken's V were interpreted to be quite high (valid), if the scores were obtained greater than 0.60. Therefore, because the results of expert validation of the content validity of the PVO Model Book, the value of V = 0.947 is obtained, which means> 0.600, so it can be stated in the valid category.

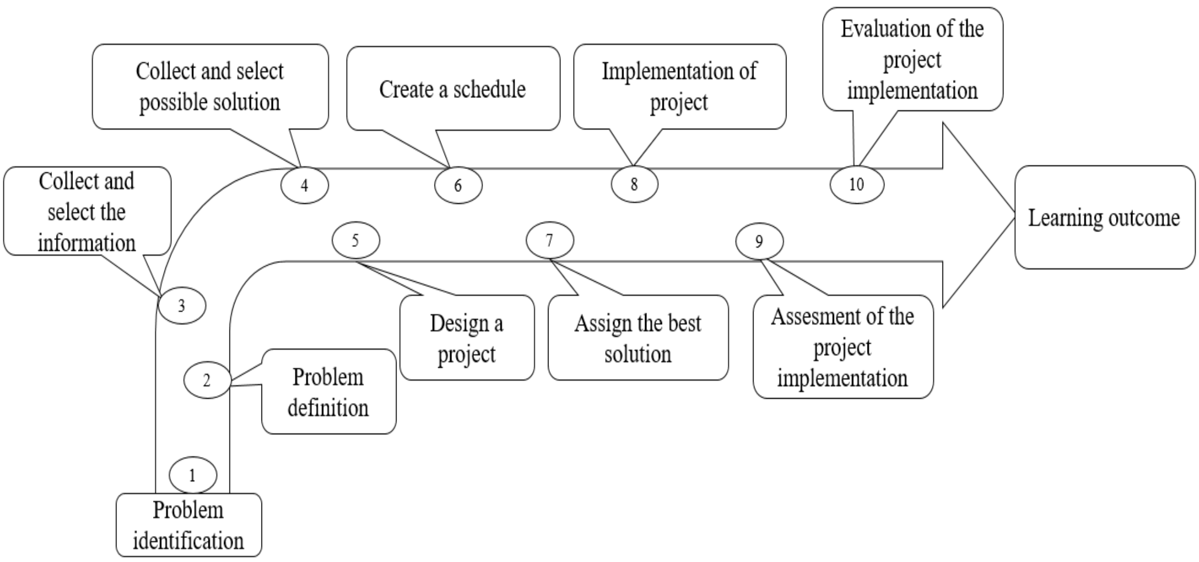
An analysis of the construct validity of the AVE model was carried out with a Confirmatory Factor Analysis (CFA). The results of data analysis show that AVE Learning Model Construction with its six components, meets the criteria for goodness-of-fit models, so that the construct validity is classified as fit or valid. In addition, it can be seen that the correlation coefficients of indicators after being linked together, all with a correlation index greater than 0.61. This means that factually, the six model variables have a close relationship with the construction of AVE learning models. This fact shows that all AVE Book Model indicators have a loading factor above 0.61, including a relationship or a solid path from component to variable and their respective indicators.

The results of data analysis of construct validity of AVE Book Model conducted with CFA, then all constructs can be categorized as meeting the criteria for goodness-of-fit models, so that the construct validity is classified as fit or valid. All syntaxes and indicators can meet the criteria of Stevens (2009) and Mayers (2003: 870), which are goodness-of-fit models and meet the criteria of (df) <2 and the model is classified as fit. The results of this study indicate that the research product has fulfilled the principle aspects of evaluation in the development of the model, namely the existence of a logical consistency between the expectation model and the reality model and the results are in accordance with Nieeven (1999). Furthermore, this validity test has used product evaluation techniques proposed by stevens (2009) in Plomp (2013), namely expert review and focus groups. Based on this theory, expert validity (expert review) is categorized at the first level in the formative evaluation techniques that have been developed. The results of expert validation (expert review) have a better level of resistance than other validation techniques.

Syntax Validity

The syntax of a model describes the overall sequence of the path which is generally followed by a series of learning activities. In this research, the syntax shows the stages of the activity, so it must clearly start from the activity, how it is carried out and what the final assessment of the series of learning activities takes place. The complete syntax of this study is shown in Figure 1 below.

Figure 01: Syntax for this study



Analysis of the AVE model syntax validity was carried out with CFA. The analysis shows that the Syntax Construction in AVE Learning Model with its ten indicators, meets the criteria for goodness-of-fit models, so that the construct validity is classified as fit or valid. In addition, it is seen that the correlation coefficients of the indicators after being linked together, all with correlation index greater than 0.57. This means that factually, the ten syntax have a close relationship with the AVE learning model. This fact shows that all AVE Model Syntax indicators have a loading factor above 0.57, including a strong relationship between the components of the ten variables and their respective indicators. The results of the construct validity of the AVE Model Syntax with 10 syntax steps and 70 indicators performed with CFA, are that all constructs can be categorized as meeting the criteria for goodness-of-fit models, so that the construct validity is classified as fit or valid. All syntaxes and indicators meet the criteria of Stevens (2009) and Mayers (2003), which are goodness-of-fit models and meet the criteria of (*x2*/df) <2 and the model is classified as fit, as shown in Table 1 below.

Table 1: Recapitulation of syntax construct validation of AVE model

NO	**Syntax construct validation**	**Chi Square > 0**	***P-value* > 0,05**	**RSME < 0,05**	$\frac{x^2}{df} <$ $2\frac{x^2}{df} < 2$	**Corelation index**	**Criteria**
1	Problem identification	26,76	0,14202	0,141	1,338	≥ 0,30	Valid/Fit
2	Problem definition	21,53	0,76094	0,000	0,797	≥ 0,30	Valid/Fit
3	Collect and select of the information	2,71	0,97467	0,000	0,301	≥ 0,30	Valid/Fit
4	Collect and select possible solution	38,56	0,06944	0,159	1,428	≥ 0,30	Valid/Fit
5	Design a project	22,58	0,30985	0,087	1,129	≥ 0,30	Valid/Fit
6	Create a schedule	3,40	0,63828	0,000	0,68	≥ 0,30	Valid/Fit
7	Assign the best solutions	22,74	0,06461	0,192	1,624	≥ 0,30	Valid/Fit
8	Implementation of the project	15,44	0,34858	0,078	1,103	≥ 0,30	Valid/Fit
9	Assesment of the project	0,84	0,97454	0,000	0,168	≥ 0,30	Valid/Fit
10	Evaluation of the project	10,32	0,32535	0,093	1,147	≥ 0,30	Valid/Fit
11	Syntax Model of AVE	3,97	0,91342	0,00	1,323	≥ 0,30	Valid/Fit

AVE model practicality

The next step after all the learning tools are validated, revised and the results have been declared valid, is the practicality test. The practicality test used in the R&D process was obtained by means of practitioners' assessments and observations by lecturers and students, responses or impressions from lecturers and students. The instrument of practicality AVE models include aspects of practicality, namely; aspects of attractiveness, ease of use, functionality and usability, reliability, sufficient time, level of difficulty in implementing, and student response. The assessment and practicality testing was carried out on all AVE product development products: (1) AVE learning model book, (2) syntax model AVE, (3) lecturer guidebooks, (4) Student guidebooks, and (5) learning modules. The results of the practicality test of the products of this study showed the level of practicability of all products in the excellent category. The results of this assessment indicate that the quality of AVE learning model, which has been selected and determined in the development method, has been fulfilled.

Practicality of AVE Learning Model Book

The practicality analysis results of AVE Learning Model Book show the average practicality assessment of the model book according to the lecturer response is 4.62 with an achievement level of 92.73 and this indicated very good criteria (very practical). This means that the practicality of the learning model book is found to be easy to understand. Furthermore, the results of research on the practicality of the AVE Learning Model Book show the average practicality assessment of the model book according to student responses is 4.35 with an achievement level of 87.06 and these are very good criteria (very practical). This means that the practicality of the learning model book is found to be easy to understand.

AVE Syntak Practicality

The results of the practicality analysis of the AVE Model Syntax show that the average practicality evaluation of the PVO learning model syntax is 4.51 with an achievement level of 90.23% and this is within very good criteria (very practical). This means that the practicality of the Learning Model Syntax in application and implementation is easily understood by students.

Practicality of Lecturer Handbook

The practicality analysis results of the Lecturer Guidance Book are that the average assessment of AVE learning module practicality is 4.65 with an achievement rate of 93.1% and this is in very good criteria (very practical). This means that the practicality of the Lecturer Guidebook has been found to be easy to understand

Practicality of student handbook

The results of an analysis of the practicality of student handbooks found that the average assessment of AVE learning module practicality is 4.40 with an achievement level of 88.08% and the handbooks achieved a very good criteria (very practical). This means that the practicality of the Student Guidebook through implementation, is easy to understand.

Practicality of student module

The results of the analysis of the practicality of the learning module are that the average assessment of AVE learning module practicality is 4.31 with an achievement level of 86.07% and the learning module falls in very good criteria (very practical). This means that the practicality of the Learning Module has been determined as easy to understand.

The effectiveness of the AVE learning module

A learning model is effective if the product developed meets the objectives from which the product is developed. Effectiveness relates to the impact of learning models designed on learning activities and learner outcomes. Reigeluth (1999) argues that the most important aspect of effectiveness is to know the level or degree of application of a theory or model in a particular situation. Regarding effectiveness in research, Akker (1999) states "Effectiveness refers to the extent that experiences and outcomes with interventions are consistent with intended aims." Effectiveness refers to the degree that experience and the results of interventions are consistent with intended goals. From the opinion above, it can be seen that a product is said to be effective if the product is appropriate in its use and utilization.

The effectiveness test was based on aspects of evaluating student learning outcomes. The learning assessment data for the Steering System, Brake and Suspension Course AVE students was collated from a test administered to a sample of 17 respondents who obtained a minimum score range of 0 and a maximum of 100. The results of empirical scores show that n = 17, minimum score = 59, 09, maximum score = 72.73, range = 20, many classes = 5, interval = 2, average = 66.042, standard deviation = 4.095, mode = 65.5 and median = 65.91.

Post-test learning value data with AVE models in the experimental class for Diploma III students in Automotive Engineering found the following empirical results: sample of 16; minimum score range 0 and maximum 100; minimum score = 84.19; maximum score = 93.58; stretch = 9.39; many classes = 5; Interval = 2; average = 88.64; standard deviation = 2.77; mode = 88.68; and the median = 88.66.

The results of the t test calculation above shows that the t-count = 9,465> t-table = 1.72 at a significant level of α-0,000, which means that there are differences in the learning outcomes of the control class students with the learning outcomes of the experimental learning classes in the Steering System, Brake and Suspension Systems curriculum. This is also indicated by the significance level of 0,000 <0.05, which means that there are significant differences between the learning outcomes of experimental class students (using AVE models) with control class learning (conventional) in the Steering System, Brake and Suspension Courses.

The results of psychomotor assessment of student learning in the control class (conventional) was an average value of 79.82 (B +) and this is in the good category. While the psychomotor assessment of student learning in the Steering System, Brake and Suspension Courses for the experimental class obtained an average value of 87% and this is in the very good category (A). Thus it can be concluded that the psychomotor ability of the experimental class students is better than the student psychomotor ability in the control class.

The results of the affective assessment of students includes cooperation, discipline, commitment, responsibility, communication, mutual cooperation, discipline, confidence and interest in AVE learning in the control class with an average value of 3.97 and an achievement level of 79.3% with good category. While the effective assessment of students in learning the Steering System, Brake and Suspension Courses in the experimental class found an average value of 4.59 with an achievement level of 91.75% and are in the very good category. So it can be concluded that the affective students in the experimental class are better than the effective students in the control class.

Student perceptions to the AVE model

In this study, students' perceptions of AVE models in learning the Steering, Brake and Suspension System in automotive vocational education was investigated. The results of the assessment of students' perceptions of AVE learning models for 4 aspects of practicality as learning atmosphere and learning interest, ease of use, interaction and effectiveness in learning, and independence, were at an achievement of 87.06% and were included in the category of very practical in implementing the AVE Model.

Teacher perceptions to the AVE model

The results of evaluating the practicality of AVE learning models based on the responses of lecturers, found that the components of the model consisted of seven aspects: attractiveness, ease of use, functionality and usability, reliability, sufficient time, difficulty in implementing, and student responses were at 92.73% achievement and included in the category of very practical in implementing the PVO Model. This practicality figure shows that the AVE model is suitable to be implemented in Steering, Brake and Suspension System courses. This is because the AVE model has fulfilled the five basic elements of a learning model according to Joyce & Weil (2003): (1) syntax; (2) social system; (3) principles of reaction; (4) support system, (5) instructional and nurturant effects. The AVE learning model is thus found to be suitable for application in automotive vocational education. The development of automotive technology is so rapid, that the endeavour must be made to ensure that automotive vocational education is not left behind in contrast to the development of automotive technology in the industrial sector. One way to overcome or narrow the gap is to apply the AVE model and actively involve students in solving real and current automotive problems in the form of allocated project problems. This is consistent with the opinion of Boud & Felleti (1991) who found that "Problem based learning is a way of constructing and learning using problems as a stimulus and focus on student activity. PBL is a learning strategy that challenges students to " learn to how learn"".

The AVE learning model when chosen and applied will have a positive influence on the achievement of student competencies. Learning models that are arranged systematically to achieve learning objectives are claimed by Eggen (2012) to "be a blueprint in teaching for a lecturer". The blueprint in this case is to provide structure and direction to lecturers in the teaching and learning process. Joyce & Weil, (2003) reinforce the finding that the learning model is a plan or pattern that can be used to shape the curriculum, design learning materials, and guide learning in the classroom or others.

Conclusion

The research has produced an AVE Learning Model with syntax consisting of 10 steps: (1) problem identification, (2) problem definition, (3) collection and selection of the information, (4) collection and selection of a possible solution, (5) design of a project, (6) creation of a schedule, (7) assignment of the best solutions, (8) implementation of the project, (9) assesment of the project implementation and (10) evaluation of the project implementation. The results of this study indicate that AVE Learning Models in the Steering, Brake and Suspension System Courses are valid, practical and effective. AVE learning model products have been validated by a team of experts with an average value of Aiken's V above 0.850. Furthermore AVE Learning Model Products received a positive response from lecturers and students as shown from the results of the assessment of the practicality of the lecturer responses, with an average of 85.93% and student responses of 87.07% with the category "very practical".

AVE Learning Model Products have been declared effective as can be seen from the results of the t-test comparison of learning outcomes between students of the experimental class and the control class, the value of $t_{test} = 9.465 > t_{table} = 1.70$ at a significant level $\alpha = 0,000$. t_{test} results showed that there were significant differences between the learning outcomes of the experimental class and the control class. For the syntax of AVE learning model and model book, construct validation with CFA was performed, with the average value categorized as meeting the criteria for goodness-of-fit models, so that the construct validity is classified as fit or valid. Thus the Model Book, Model Syntax, and the developed indicator can be described related to each syntax.

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