Development of a self-directed learning model based on independence with a differentiation approach to improve higher order thinking skills of vocational high school students

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Article Info

ABSTRACT

The Self Directed Learning Model is an independent activity that requires students to think critically and solve the problems. The aim of the research is to produce a Self-Directed Learning model based on independence with a differentiation approach to improve the higher order thinking skills of State Vocational School (SMK) students in North Bengkulu. The research uses the Research and Development method with a 4-D development model design consisting of definition, design, development and dissemination. The sample was chosen randomly and purposively sampling. Data collection uses questionnaires, interviews, validation and documentation. The results obtained in the research are an independence-based Self Directed Learning model that suits the needs of students at SMK Negeri 2 and SMK Negeri 5 North Bengkulu. The feasibility of the Independence-based Self Directed Learning model was validated by expert validators, vocational basics subject teachers.

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Introduction

Vocational school learning, which is often directed at academic abilities, focuses on mastering concepts, thereby reducing students' ability to think. For this reason, teachers need steps that make students capable of critical thinking, complex and creative reasoning. The few research results show that students' thinking abilities are still low, as stated in the results of the third international mathematics and science study (TIMSS) research study which also shows that Indonesian students' thinking abilities are still relatively low, namely below 30% (Fitriani, A, 2013). Students' thinking abilities in learning according to TIMSS are having good abilities, being able to learn quickly and never giving up, being confident in their abilities and being able to think realistically.

Challenges in the field of education are currently increasing, the demands of modern society are increasingly complex, the results of the world education ranking published by the Organization for Economic Co-operation and Development (OECD) in 2021, Indonesia is ranked 57th out of a total of 65 countries. From these results, there are many things that must be improved in the education process in Indonesia, one of which is the learning process. Research results from (Esposito & Bauer, 2022) state that teaching experience and learning model planning carried out by teachers have a significant influence on the effectiveness of the learning process and student learning outcomes (Dewi, 2016).

Effectiveness in the learning process allows students to learn easily, have fun, and can achieve learning goals in accordance with a teacher's expectations (Munna & Kalam, 2021). Learning that often occurs in the classroom is still dominated by teachers, so that the learning carried out in the classroom is less effective (Brophy & Good, 1970). Achieving learning effectiveness requires an appropriate learning strategy according to the students' conditions. The condition of students in the learning process is important in achieving optimal results, so strategies are needed that are appropriate to students' conditions so that the objectives of learning can be achieved well (Huang & Chiu, 2015). Currently there are still many teachers who use conventional methods or lecture methods, students are only loyal listeners and cannot be active in the learning process, this is supported by a statement from (Ucar & Trundle, 2011) which states that learning strategies are a learning activity what teachers and students must do so that learning objectives can be achieved effectively and efficiently

The role of teachers in implementing the 2013 curriculum (K-13) has consequences for teachers to be increasingly qualified in carrying out 21st century learning process activities which include 4C and HOTS (Higher Order Thinking Skills). The implementation of 21st century learning needs to be carried out contextually using models, strategies, methods and techniques in accordance with the characteristics of Basic Competencies (KD) so that learning objectives are achieved (Sajidan & Afandi, 2017). 21st century learning is simply defined as learning that provides 4C skills to students, which include: Communication. Collaboration, Critical Thinking and problem solving, and Creative and Innovative (Ulfert-Blank & Schmidt, 2022; Walid et al., 2019)

21st century learning apart from providing skills to students also develops knowledge, where 21st century National Education aims to: 1) develop the ability to form a dignified national character and civilization in order to make the nation's life more intelligent; 2) develop the potential of students to become human beings who have faith and are devoted to God Almighty, have noble character, are healthy, knowledgeable, capable, creative, independent, become democratic and responsible citizens (Sudarmin et al., 2017). It is very important for education in the 21st century to improve its quality in order to ensure that students have the skills to learn and innovate (learning and innovation skills), in using media, information and technology (media, information and technology skills), and can work and survive using skills for life (life and career skills).

The application of 21st century learning (4C) and HOTS in learning aims to improve the quality of education in order to answer challenges, both internal challenges in order to achieve 8 (eight) SNPs and external challenges, namely globalization. To realize the above, the teacher as the spearhead of learning must be able to plan and implement a quality learning process. Teachers must have good process skills in learning. Process skills can be interpreted as teacher skills in presenting learning that is able to provide meaningful and enjoyable learning experiences for students (Yuliati, 2017). However, this is in contrast to the results of observations and interviews with teachers at vocational schools, a number of teachers still find it difficult and reluctant to reform themselves according to the demands of 21st century education, this is accused of being a triggering factor for low educational attainment results in Indonesia.

This research is motivated by the lack of implementation of competency improvement in Automotive Light Vehicle Engineering (TKRO) skills in Vocational High Schools.The results for the critical thinking aspect before the Self-Directed Learning model was implemented was 58.05%, while after the independence-based Self Directed Learning model was implemented, it increased to 81.45%. In the problem-solving aspect it increased from 55.91% to 67.20%, by the principal for practical teachers in the Automotive Light Vehicle Engineering department at SMKN 2 and SMKN 5, North Bengkulu. What was found in the learning process was that teachers had not used adequate learning tools, and also applied models in every learning activity, causing student learning outcomes and student abilities to remain low. This is also reinforced by research results which reveal that the learning process will get optimal results if the learning process uses adequate and effective learning models and tools carried out according to procedures (Belland et al., 2017). The aim of the research is to produce a Self-Directed Learning model based on independence with a differentiation approach to improve the higher order thinking skills of State Vocational School (SMK) students in North Bengkulu.

Method

The development model that will be used in this research is the Four-D development model. The Four-D model was proposed by Thiagarajan, (1974) was developed specifically to develop various special needs in education. In this Four-D model, there are 4 stages of development, namely: define, design, develop, and disseminate. The first, the define stage is the collection of initial information including searching for references or reviewing the literature, making observations and conducting a needs analysis. And in the define had 5 stages are carried out, namely analysis, initial needs, student analysis, task analysis, concept analysis and formulating learning objectives.

Second, the Design Stage includes; (1) preparing references related to self-directed learning, (2) selecting an appropriate learning model, (3) determining a syntactic design that collaborates between direct learning capabilities, independent learning, differentiation approaches and critical thinking and problem solving abilities, and (4) format selection in determining instruments for model experts, material experts and language experts. Third, Development Stage, which will be carried out to produce a learning model through various stages of improvement, through (1) Validation of the device, (2) Product Trial on X TKRO students in small groups, (3) Wide group trial at 2 vocational schools . And the last fourth stage, Disseminate, was the researcher socialized the development product to all vocational schools in North Bengkulu through the school principal's work deliberation forum (MKKS) by a presentation.

Data collection uses questionnaires, interviews, validation and documentation. The Respondents were 68 students consisting of 2 TKRO classes (1 experimental, 1 control) at 2 schools, namely SMKN 2 and SMKN 5, North Bengkulu. The results obtained in the research are an independence-based Self Directed Learning model that suits the needs of students at SMK Negeri 2 and SMK Negeri 5 North Bengkulu.

The type of research and development carried out is seen from the use of theory, including applying theory and producing products. Application of theory and product production carried out with field research and library research; by using survey research and experimental research techniques; is applied research to produce a product (Manora, 2019).

Data collection techniques in this research are (a) observation (b) interviews, (c) database, (d) documentation. In analyzing this data, the parameters proposed by Arikunto, (2014) were used by interpreting the data results into percentage criteria for psychological skill dimensions.

Result and Discussions
Content Validation Analysis Results from Expert Responses
Data from validation results from six experts on aspects and indicators of Knowledge Transfer, Critical Thinking and Problem-Solving aspects for model design, language and material indicators are presented in Table 1 and the complete data is attached in the attachment.

Table 1. Results of Design Validation Analysis, Language and Material Content

No	Questionnaire	Aiken's V Mean			Critical Value	Criteria
		Model Design Expert	Linguist Expert	Material Expert		
1	Independence-based SDL	0,90	0,96	0,92	$V \geq 0,79$	Very good

V aiken was obtained based on the results of assessments from 6 experts on the independence-based Self Directed Learning prototype in terms of the extent to which the indicators represent the construct being measured. Validation of the model design uses the instrument developed, while the number of raters (n) = 3, and number of rating categories (c) = 4. The data results in Table 4.2 of the assessment items for the model design aspect are relevant to the behavioral indicators because the behavioral indicators are the operationalization of the latent attribute being measured. The behavioral indicators referred to in this assessment are model indicators developed in accordance with the Independence-based Self Directed Learning indicators, the content of the material asked is contextual. The data was then analyzed using the Aiken formula and based on the table (Aiken V), a V value of 0.90 was obtained with a critical value $\geq$ 0.79, so the results

Results of Learning Model Validation Analysis from Teacher Responses
In this data analysis, the parameters proposed by Suharsimi, (2013) were used by interpreting the data results into percentage criteria for psychological skill dimensions. The scores resulting from the validation of the learning model from experts are then presented in the form of a bar chart which is presented in Figure 1.

Referring to the results of the validation data analysis of the Independence-based Self Directed Learning Model by learning experts, a percentage value of 83.63% was obtained. When interpreted in the form of qualitative data, this value falls into the "Very Good" category. So, the Independence-based Self Directed Learning Model passes the test.
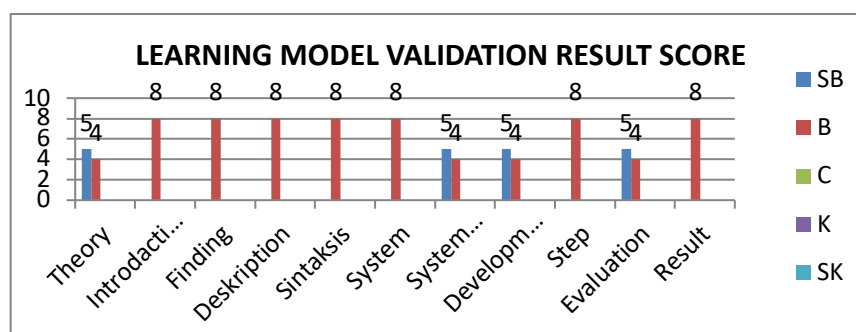
Figure 1. The scores resulting from the validation of the learning model

Results of Learning Model Analysis from Student Responses
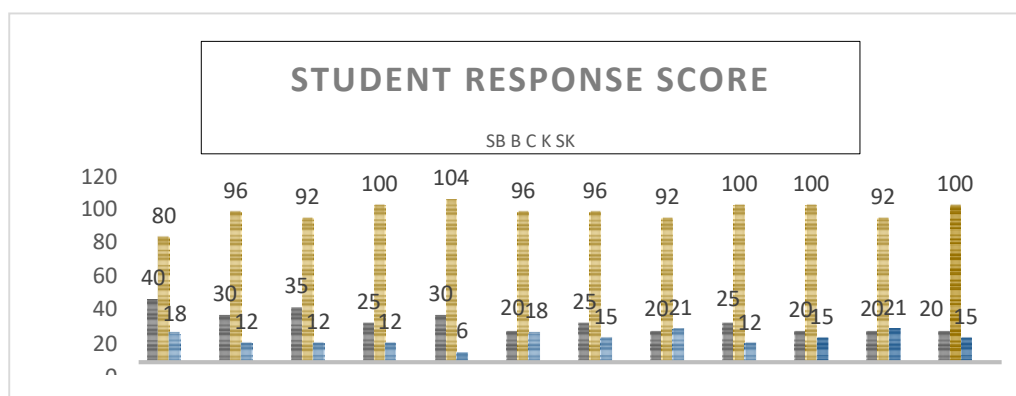

Figure 2. Bar Diagram of Student Response Scores to the Self-Directed Learning Model

Referring to the results of data analysis of student responses to the Independence-based Self Directed Learning Model, a percentage value of 80.14% was obtained. When interpreted in the form of qualitative data, this value falls into the "Good" category. So, the Self-Directed Learning Model based on Independence passes the test and can be applied in Vocational High Schools.

The next stage is to determine the effectiveness of implementing the Self-Directed Learning model on students' high-level thinking abilities in Vocational High Schools. This learning model was applied to a sample of class X Automotive Light Vehicle Engineering (TKRO) A and Light Automotive Vehicle Engineering (TKRO) B from a population of class normality and homogeneity in the population.

The research data is in the form of learning outcome data which covers the realm of knowledge and the percentage results of increasing abilities in aspects of students' critical thinking and problem solving. Learning outcomes in the knowledge domain are obtained from giving a written test which is carried out after learning, while the percentage results for assessing critical thinking and problem-solving abilities are obtained from students' self-assessment scores after the learning process. The implementation of this research used an experimental class, namely class X Automotive Light Vehicle Engineering (TKRO) A with a total of 34 students. The control class is class X Automotive Light Vehicle Engineering (TKRO) B with 34 students, each class as assessment data for two domains of learning outcomes. Learning in the experimental group in class the control group in class X TKRO B was not given treatment. The results of the pre-test and post-test data were analyzed using the t test. Data taken from the experimental and control groups were analyzed statistically. The results of statistical calculations are in the form of significance values. Comparison of significance values with t-table values shows whether there is a difference or not in the application of the Independence-based Self Directed Learning Model in the experimental and control groups. Development products that have undergone a validation and feasibility test process and also tested for practicality and effectiveness can be seen at the following link https://shorturl.at/hBO03.

Based on the assessment of 6 vocational teachers at TKRO, the practicality score of the model which was assessed based on 12 aspects, overall the teacher's response to the self-directed learning model on students' level thinking abilities was an average of 47.5%. So it can be concluded that the model developed is practical to use.

Table 2. Practicality Test Calculation results and Product

No	Teacher Code	Total number of aspects assessed	Amount Calculation
1	INS	56,4	4,7
2	FH	55,2	4,6
3	RKI	57,6	4,8
4	BS	58,8	4,9
5	MF	55,2	4,6
6	BAW	58,8	4,9
	Mean		**47,5**

Characteristics of the Learning Model required

Efforts that need to be prepared by teachers to find out the learning models needed by students are by knowing the characteristics of the students. This is in line with the results of research from (Lailan, 2017); (Amin et al., 2020) explains that the teacher's readiness to recognize student characteristics is the main asset in determining a learning model that is able to deliver learning materials and is an indicator of successful learning implementation. According to the 2013 Curriculum Commission, learning that must be implemented is learning that can develop high-level thinking skills (HOTS) which include problem solving, creativity, critical and decision-making skills (Sudarmin et al., 2017). Education can teach critical thinking skills to anyone because education plays an important role in shaping a person's attitudes, knowledge and skills (Emosional et al., 2020). However, low critical thinking skills are a reality faced by the world of education both nationally and internationally. Evidence of the low critical thinking skills of Indonesian students can be provided from the results of interviews between researchers and teachers at SMK Negeri 2 and SMK Negeri 5 North Bengkulu which show that the results of student studies in the final semester exams which have used HOTS-based questions with KKM 70 show that 25% of students got a score above the KKM, while 75% of students got a score below the KKM. Inadequate learning outcomes are believed to be the result of students' lack of critical thinking skills and the impact of less-than-optimal learning processes (Saputri et al., 2019). The low critical thinking skills of students are caused by the learning model not being well defined to improve students' high level thinking skills. Interview results show that students only read books if the teacher gives assignments to students and students look for reference answers in books and read books. When the researcher made observations in the classroom during the learning process, information was obtained that was the same as the information obtained during the interview, namely that students were provided with a textbook and the teacher gave several essay questions in it (Bruce Joyce, 2009).

Apart from conducting interviews with vocational teachers in Automotive Light Vehicle Engineering (TKRO), researchers also conducted interviews with several students. The results of the interviews also found the same problem that some students did not like basic vocational subjects because the learning process was less enjoyable, this was because the teacher delivered the material monotonously and students were only interested in reading books if the teacher gave students assignments to read. This is in accordance with the results of research conducted by Fuadi, (2019) that in Indonesia they still rely on textual books so that they do not fully touch the souls of students, as a result the learning process becomes boring. The results of this research are in line with the results of research from (Hakim & Saputra, 2018), which shows that a monotonous learning model will make students feel bored and not interested in participating in learning.

Based on the information above, the solution to overcome this problem is to develop a learning model that encourages students to think critically. This has an effect on increasing students' high-level thinking abilities. Therefore, awareness is needed for teachers by emphasizing the importance of active learning models and inviting student motivation as an important factor to improve their critical thinking abilities (Setyarini & Jannah, 2020). Based on research results from (Mengel et al., 2019). The application of the Self-Directed Learning model in learning effectively improves critical thinking skills. Thus, the conclusion is that to overcome the low level of students' critical thinking abilities and teachers' confusion in determining which learning model is suitable for improving students' high-level thinking abilities is to develop an Independence-based Self Directed Learning Model. Not only that, independent learning can develop students' abilities to build deeper knowledge from the information they learn independently (Song et al., 2022). Other evidence that shows that the self-directed learning model can improve students' high-level thinking abilities is from research results (Al-Adwan et al., 2022), the application of the self-directed learning model can improve students' critical thinking due to high curiosity.

Feasibility of Learning Model

The validity of the learning model that has been developed needs to be tested to determine the feasibility of the learning model through validation from experts and the audience. This stage aims to find out whether the learning model is feasible or not to be tested (Rerung et al., 2017; Abdi et al., 2013) One of the requirements for

a learning model to be considered feasible is that it meets theoretical feasibility through expert validation. Theoretical feasibility consists of eleven criteria, namely supporting theory of the learning model, background of model development, development objectives, model description, model syntax, model social system, support system, learning approach, learning steps, evaluation and assessment, as well as learning outcomes. desired (Vrindt et al., 2022). Thus, it can be concluded that measuring the feasibility of a learning model can be done through expert validation which is divided into the eleven development criteria. Guided by the criteria above, the feasibility of the self-directed learning model based on independence was validated by the engineering mechanics subject teacher. The results of the construct expert validation based on V Aiken seen from the design, material and language as a whole obtained an average assessment ranging from 0.92 which can be interpreted as meaning that if the value is ≥ 0.79 which is the critical value then the development product, in this case is a learning model Self-directed learning based on independence is declared valid and suitable for use. The validation results of the self-directed learning model based on independence were declared feasible with a percentage of 83.63%. Meanwhile, the results of student responses (audience) from the development of the independence-based Self-directed Learning model to measure Higher Order Thinking obtained a percentage of 80.14%, which shows that the independence-based Self-directed Learning model to measure Higher Thinking Skill is feasible and valid to be tested.

In strengthening the discussion obtained in this research, other research conducted by (Albaar, 2015) revealed that the IT-based SDL model had an effect on the critical thinking skills and learning independence of class XI Science students at SMA Negeri 1. Critical thinking skills and student independence showed better results after following chemistry learning with the IT-based SDL model. Other research conducted by Turmuzi et al., (2022) revealed that to foster an entrepreneurial spirit in students, students must have the ability to direct themselves, be self-confident, action-oriented, energetic and tolerant of uncertainty. This is also supported by research by Rerung et al., (2017) regarding the influence of the problem-based learning model with a socio scientific issue approach in science learning on higher order thinking skills and learning activities, revealing that the use of the problem based learning model with a socio scientific issue approach has an effect on student learning activities.

Other research explains that self-directed learning shows that there is a difference in increasing students' mathematical understanding abilities between students who receive learning using the self-directed learning model and students who receive learning using conventional learning (Al-Adwan et al., 2022). This is also supported by other research which reveals that what can be seen is increasing students' theoretical understanding and testing the effectiveness of the material being tested with effective results (Vennix et al., 2018).

Effectiveness and Practicality of the Learning Model
The learning model that has been developed needs to be tested for its effectiveness by looking at the relationship between the learning model developed and the theory underlying the preparation of the learning model. The theory underlying the preparation of this Self-Directed Learning model is constructivist learning theory. The relationship between the concept of constructivist learning theory and teaching materials according to Hamid et al., (2019), namely that the learning process is not oriented towards delivering learning objectives and materials directly, but in the form of an invitation to students to carry out observations and social analysis in accordance with material structures that are arranged in an orderly manner. independently by students. So, the point is that teaching materials function to attract students' attention to make observations and social analysis of existing materials and then rearrange them according to students' understanding.

This independence-based learning model has the same orientation and function as the concept of constructivist learning theory, namely providing motivation and making real observations in nature by relating the material in the book so that it can attract students' attention. Furthermore, the independence-based SDL learning model can invite students to carry out observations and analysis of building materials according to students' understanding.

The effectiveness of a learning model is the accuracy in achieving the learning objectives that have been set Segoro et al., (2019). The learning model can be said to be effective if the application of the learning model developed in the experimental class is better than the control class (Bien, Daniel & Tanco, 2019). Thus, the achievement of learning objectives with a developed learning model rather than not using a developed learning model is a determinant of the effectiveness of implementing the learning model.

The results of the t-test calculation analysis on the Knowledge Transfer Aspect to determine the effectiveness of implementing the Self-Directed Learning model obtained the following data (Table 2).

Based on the table above, it can be seen that the learning outcomes in the knowledge domain of the experimental group with the Self-directed Learning model got a class average score of 86.261, which means it was higher than the control group which got a class average score of 81.669. This is because in the experimental group which applied the Self-directed Learning model, the teacher encouraged students to solve each problem

independently so that their insight increased. The teacher succeeded in implementing the learning on Bar Style Competency Standards in crane construction which was able to attract students' attention, resulting in increased learning outcomes. Assignment sheets can also help teachers make it easier to convey material so that students can easily understand the material presented. Apart from that, by giving students different and HOTS-based questions, student independence can increase. Students can also practice responsibility for the questions that must be solved. This aims to develop students' way of learning, which is usually without handbooks and memorizing, to be more creative and innovative, so that students are motivated to learn.

Table 2. T-Test Calculation Results Learning Results in the Domain of Knowledge of the Experimental Group and Control Group

Group	Average	Variants	t count	t table
Experiment	86,261	24,6831	3,8070	1,6686
Control	81,669	24,7980		

The results of observations can be seen that the Self-Directed Learning model using rod style material on a simple frame is more effective because it can improve students' high-level thinking abilities in the Knowledge Transfer aspect, both in terms of knowledge and skills, and can also increase students' motivation to solve problems independently. Data on the learning outcomes of the basics of vocational competence in the engineering mechanics subject of Automotive Light Vehicle Engineering (TKRO) in both domains obtained in the t-test hypothesis shows that there is a difference between the experimental class and the control class in the Knowledge Transfer aspect of the basics of vocational class students X SMK Negeri 2 and SMK Negeri 5 Bengkulu Utara Academic Year 2022-2023 on the learning outcomes of the domain of knowledge and skills. The minimum, maximum, average and completeness scores obtained from the experimental group were higher than the control group. Based on this, it can be seen that the learning outcomes in the realm of student knowledge and skills given the Self-Directed Learning model are effective in improving high-level thinking abilities in the realm of Knowledge Transfer in vocational school students. The results of the analysis of the N gain Score test for the Knowledge Transfer aspect were found to be 0, 49 The N-gain Score category is in the medium category, so it can be stated that the effectiveness of the self-directed learning model is effective in improving students' high-level thinking abilities in the aspect of knowledge transfer.

Based on the t test obtained, it produces knowledge abilities (t count = 3.8070 > t table 1.6686 and skills (t count 2.6620 > t table 1.6686) on student learning outcomes in basic vocational basic material. This shows that the Independence-based self-directed learning model is better than the previous learning model which is usually used by subject teachers. Apart from the Knowledge Transfer Aspect, the effectiveness of the self-directed learning model can be determined based on the results of the analysis of the percentage increase in the problem solving and critical thinking aspects. Percentage This was obtained from a self-assessment filled in by students from the experimental group both before and after receiving the Independence-based Self Directed Learning Model. Data analysis was obtained from many students in answering points on each criterion, then compared before and after the self-directed learning model was applied. learning. Following are the results of the percentage increase in problem solving and critical thinking abilities of students in the experimental group before and after receiving treatment.

Based on the bar diagram in Figure 4.5, it can be concluded that there has been an increase in students' high-level thinking abilities in aspects of critical thinking and problem solving. The percentage increase in the critical thinking aspect from before the self-directed learning model was implemented and after the learning model was implemented increased by 23.50%. The percentage of problem-solving aspects also increased by 11.29%. Thus, it can be concluded that the Independence-based Self Directed Learning Model is effective in improving students' high-level thinking abilities in the aspects of critical thinking and problem solving.

The results of the research above are supported by research conducted by Song et al., (2022) with a discussion of the influence of the self-directed learning model in the era of independent learning on writing skills, revealing that the Self-Directed Learning model is very relevant to the goal of independent learning, namely that it both requires students to learn independently according to their needs, talents and interests. This is also reinforced by research by Goepfert et al., (2019) that the effectiveness of observing attitudes, knowledge and skills in Mechatronics material among students who have applied SDL has more value than students who have applied SMK. Al-Adwan et al., (2022) revealed that the self-directed learning model can increase student learning independence so that there are quite significant differences between the group of students who study using the self-directed learning model and the group of students who study using conventional learning.
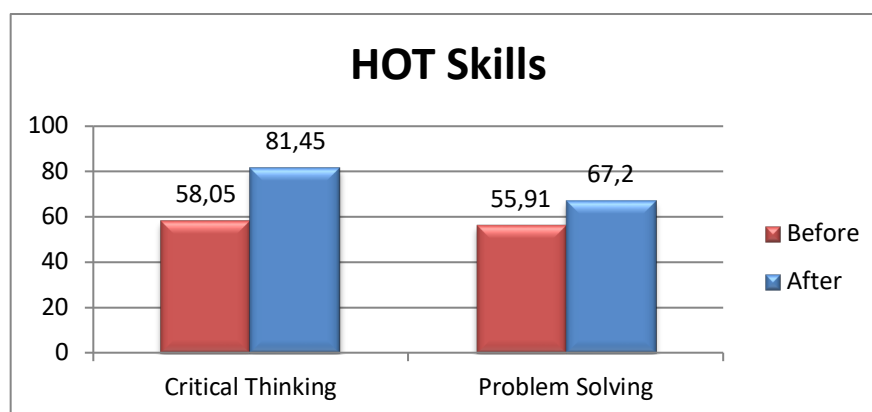
Figure 3. Bar chart of percentage increase in HOTS ability in critical thinking and problem-solving aspects

The discussion regarding the effectiveness of this learning model is also supported by research conducted by (Suarni, 2019) showing that the implementation of Google Classroom-based Self-Directed Learning is no better than conventional learning. However, if we look at the average difference which is not very significant, then the application of Self-Directed Learning based on Google Classroom is still suitable to be used as a substitute for learning if the teacher is unable to attend. This was confirmed by (Kurniawati, 2018). The results of this analysis showed that independence in learning and achievement motivation had a positive and significant influence on reading learning achievement.

Practicality analysis carried out by teachers in the Independence-Based Self Directed Learning Model with a differentiation approach to improve Higher Order Thinking Skills is based on the scores obtained from the practicality sheet for teachers. The results of the average practicality score obtained were 47.5 so it was adjusted to the model criteria, namely if the average practicality score was categorized as practical, or very practical then there was no need for improvement. The limitations of this research are firstly the time of the research, so it has not yet reached the very practical category level, secondly the results of student responses from the development of self-directed learning based on independence are 80.14% which means it is feasible and valid to be tested, thirdly the effectiveness gets a score of 0.49 where N- The gain score is in the medium category. So it is effective in improving students' high-level thinking abilities.

The implications of this research are theoretical implications and practical implications. Where the Theoretical Implications are the application of a self-directed learning model based on independence which can hone critical thinking and problem solving skills, while the Practical Implications can be used by teachers as input to improve the learning outcomes achieved by students in vocational subjects.

Conclusions

Based on the results of the research and discussion described in the previous chapter, the following conclusions can be drawn. The independence-based self-directed learning model has the characteristics of learning that is faced with problems and provides opportunities for students to solve them independently. This reveals that the characteristics of decision making in solving problems are still low, so a way is needed to develop a learning model with a combination of problem based learning and inquiry to achieve the goal of improving students' high level thinking abilities in three aspects, namely the knowledge transfer aspect, the critical thinking aspect and the problem solving aspect. The feasibility of the Self-directed Learning model based on Independence was validated by expert validators, teachers of basic vocational subjects.

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