JURNAL EDUSCIENCE (JES)
p-ISSN : 2303 - 355X | e-ISSN : 2685 - 2217
PUBLISHED BY : LPPM of UNIVERSITAS LABUHANBATU

Development and Validation of Vocational Literacy-Based Learning Model

Riyan Arthur[1*], Arris Maulana[2], Sunita[2]

[1] Educational Research and Evaluation, Postgraduate Universitas Negeri Jakarta, Indonesia
[2] Building Engineering Education, Universitas Negeri Jakarta, Indonesia
*Email: arthur@unj.ac.id

ARTICLE INFO

Keywords:
Vocational Literacy
Vocational High School
Learning Model

ABSTRACT

Purpose – The development of technology presents new challenges, along with the weakening of literacy culture. In the learning process at SMK, project-based learning still uses conventional models, and students still do not understand them. The drawback is in the syntax used; a leap in stages should allow students to explore the product first. On the other hand, literacy has a strategic role in developing the competencies of Vocational High School students. This study aims to develop a vocational literacy-based learning model in vocational schools.

Methodology – The research method used is the Traditional mix method, which is limited to the stage of development (development) and expert validation by involving experts in the fields of learning design and language. The result of this study is the syntax of a vocational literacy-based learning model.

Findings – The final validation analysis by experts yielded validity values of 0.80 (learning design) and 0.79 (language).

Significance – This means that this vocational literacy-based learning model is feasible for use in teaching and learning activities at the vocational level.

Received 22 November 2024; Received in revised form 27 November 2024; Accepted 27 February 2025
Jurnal Eduscience (JES) Volume 12 No. 1 (2025)
Available online xx February 2025

INTRODUCTION

The rapid development of technology today has caused problems, especially in the weak culture of literacy (Herawati et al., 2019), which can be seen from the results of the international scale literacy culture assessment by the Program for International Student Assessment (PISA) which shows low national literacy and numeracy ability scores, namely 70% of Indonesian students are below the minimum reading competency level, and 71% are below the minimum numeracy competency level (Direktorat Jenderal Pendidikan Vokasi, 2022). Literacy skills have an important role in supporting the development of a person's competence, especially in the current era. Literacy is not only related to speaking and writing, but literacy must also be improved, including data literacy, technology literacy, and human literacy (Maharani et al., 2023; Nadir et al., 2022). A good understanding of literacy allows someone to understand various types of information and

improve skills in communicating, collaborating, thinking critically, creatively, and innovatively to maximize competence in the younger generation (Binkley et al., 2012; Haug & Mork, 2021; Inderanata & Sukardi, 2023). Based on the results of the literature review, the challenges faced by many teachers in vocational schools are the difficulty of adjusting learning plans to the curriculum that emphasizes student-centered learning and the use of technology (Dwita & Susanah, 2020; Jauzy et al., 2024). Most of the learning is still teacher-centered and less than optimal in involving students in critical and creative thinking. The projects given often only focus on product results without emphasizing the process needed to build competence comprehensively.

Currently, the government has developed a more flexible curriculum. The 2013 curriculum was simplified and focused on essential materials to become an independent curriculum (Lutfiana, 2022) as an attempt to improve and restore post-pandemic learning, as well as an effort to improve the quality of education (Khoirurrijal et al., 2022). Referring to the certification strategy of the Indonesian National Qualification Framework (KKNI), graduates of Vocational High Schools (SMK) are expected to be able to achieve KKNI Level II. For students to obtain competencies according to the SKKNI strategy, a learning model is needed that can be adapted to the learning elements in SMK (Estriyanto et al., 2017; Krötz & Deutscher, 2021). The learning model is an urgent matter that is raised because the learning model is a large umbrella in carrying out holistic learning, including the instillation of technical competencies, soft skills, and professional competencies simultaneously, which are characteristics that are the strengths of Vocational High Schools (SMK). One of the learning models often used at the SMK level is project-based learning (Ewing, 2017). However, teachers need assistance in preparing lesson plans that must be aligned with the steps in the learning model according to the current curriculum, which currently emphasizes student-centered learning (Heinze et al., 2018; Rohr-Mentele & Forster-Heinzer, 2021). In addition, the development of technology forces teachers to apply it in every learning, especially project-based learning. This condition causes problems where teachers feel uncomfortable and cannot apply technology in learning. Lack of knowledge and competence, age, and limited time to master technology hinder this progress (Tusiime et al., 2022).

The learning model has an important role in creating a comfortable learning atmosphere so that students' enthusiasm for learning can increase and learning objectives can be achieved (Yang, 2015). The learning process can be improved if the arranged steps in the learning model run smoothly. Therefore, an innovative learning model is needed that focuses on developing cognitive aspects and can achieve affective and psychomotor aspects, including the formation and strengthening of student character (Salzmann et al., 2018; Schneider et al., 2018). Implementing the project learning model is still carried over to the conventional model, where the learning carried out tends to prioritize teacher-centered learning (Melles et al., 2019; Wannapiroon et al., 2021). On the other hand, students are required to improve their critical thinking skills. Therefore, learning should be carried out in a student-centered manner. The teacher makes slight changes to the existing RPP without adjusting the model syntax and the material to be delivered to make learning more optimal with the expected goals (Ferm, 2021). Teachers often give projects that only focus on the results in the form of products. This needs to be considered sufficient to achieve the competencies needed in learning. Teachers indeed emphasize the process carried out by students to grow and develop students' knowledge, skills, attitudes, and character (Deutscher & Winther, 2018).

Several studies on the learning process state that students need help to understand the learning process using a project model where the main problem lies in the unclear directions in the learning process so that students are unable to deeply understand the steps they must take to complete the project (Mulyadi, 2016). In addition, many students have difficulty if they are required to think creatively in exploring the projects given during learning, with the main obstacle being the lack of deep understanding of the basic concepts that support the project so their exploration and innovation abilities are limited (Furi et al., 2018). The learning process is what students need to develop their abilities optimally (Anggraeni & Akbar, 2018). On the other hand, teachers must be the driving force in designing, compiling, developing, evaluating, and following up on students learning (Ariga, 2023). The next stage is the stage of preparing a production schedule. At this stage, teachers and students should determine the steps used to complete the product and the schedule for completing the product (Anggraini & Wulandari, 2020). The syntax of the project learning model that is commonly used today shows that there is a jump in the learning process from the first stage, namely "giving basic questions," to the

second stage, namely "designing a product," even though before the product design stage students can be given directions to explore the product to be developed, where this will make students better understand the topic of discussion regarding the product and gain essential knowledge related to the material itself (Wijayanto et al., 2020). This syntactic jump allows most students to work on projects different from the material they should be working on (Wahyu, 2016). This can happen because students receive an inappropriate learning interaction process, so topics related to the products to be made or developed cannot be understood properly (Hazmi, 2019). The above problems illustrate the need for innovation that can provide a middle ground for teachers to adapt to existing learning more efficiently. This means developing a learning model based on learning needs is necessary, especially for an independent curriculum.

In line with literacy, research related to this at the secondary school level has developed from developing science literacy into vocational literacy (Arthur, Maharani, et al., 2023a). The theory and concept of vocational literacy are intended to measure the competencies possessed by vocational school graduates, especially knowledge, communication, and elaboration skills, as well as career planning skills (Arthur, Luthfiyah et al., 2023; Rouf et al., 2021). Vocational literacy is a concept consisting of 4 main dimensions as its components, namely the dimensions of knowledge context, knowledge mastery, competency achievement, and work attitude dimensions. The dimensions in vocational literacy are further developed so that four indicators are born as components of each dimension. The four indicators are work readiness, response to technology, formation of communication, and collaboration skills (Arthur et al., 2021) (Arthur, Maharani et al., 2023b). Learning outcomes in the current curriculum are like the existing concept of vocational literacy. This allows both concepts to be combined to develop a learning model that aligns with the needs of vocational education, called a vocational literacy-based learning model. As seen in the image below:

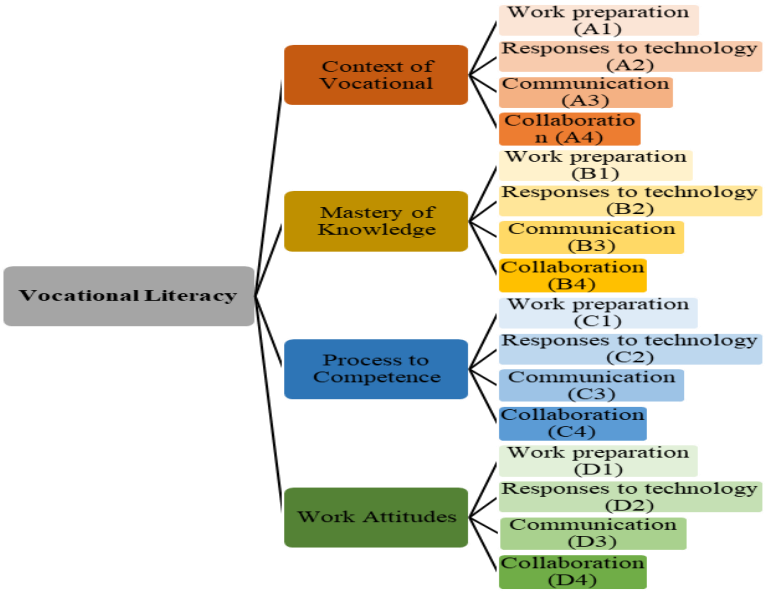

Figure 1. Vocational Literacy Framework (Arthur et al., 2023)

The vocational literacy-based learning model is a learning model designed to have a systematic syntax with detailed stages, where the use of this learning model is expected to create a pleasant learning experience so that students can design, develop, and implement various things that are in front of them and have work skills as one of the efforts to improve the quality of vocational education graduates. The development of the syntax of the vocational literacy-based learning model is one of the steps to redesign the learning model in vocational education by adopting four indicators contained in the four dimensions of the vocational literacy concept, namely knowledge, digital technology, and information and communication (Hadi et al., 2021). In addition, the vocational literacy-based learning model is expected to meet the success indicators of Vocational High School (SMK) graduates in the form of absorption in work units according to expertise programs, SMK graduates with a waiting period of less than 2 years to enter the workforce, and SMK graduates can develop

themselves to the competency stage of the expertise work unit (Ulum & Ismanto, 2017). Based on the description above, developing the syntax of the vocational literacy-based learning model is necessary. The syntax is developed based on the existing project learning model. The vocational literacy-based learning model aims to provide more practical encouragement and can be directly applied at the vocational education level.

METHODOLOGY

Research Design

This study used the Traditional Mix Method, commonly used to produce a new product; in this case, it is the syntax of the vocational literacy learning model. This model is well-suited for developing educational products through learning model syntax based on vocational literacy, enabling students to become more innovative, factual, and inspiring. This study is confined to the development and expert validation stages.

Participants and Instruments

The population in this study were students at State Vocational High Schools in Jakarta, with the subjects of the study being students at Vocational High Schools majoring in Building Modelling and Information Design and taking samples from schools located in central Jakarta and the north of Jakarta who have very different backgrounds a comparison. The sample used was 32 students of SMK Negeri 1 Jakarta and nine students of SMK Negeri 56 Jakarta using a simple random sampling technique, namely a questionnaire sheet containing open questions or statements given to experts, namely learning design experts, material experts, and language experts. Students participate in learning by implementing a vocational literacy-based learning model. The respondents determined were students and educators of the Building Modelling and Information Design (DPIB) expertise program. Students involved in this study were grade XI (eleven) students who took the Construction Cost Estimation / Budget Plan subject.

Data Analysis

The data analysis techniques used in this study include qualitative and quantitative analysis. The qualitative analysis includes analysis of expert opinions that lead to revision activities for the developed product. The instruments used in this study have been validated, including three learning design instrument experts, nine material experts from various vocational schools in Jakarta, and three language experts' data validation in the form of responses from experts is then analyzed by calculating the content validation coefficient using the Aiken's V formula. Data from validation by learning design experts and language experts are measured using the Likert Scale (Maulana et al., 2022). For the instruments given to the learning design experts, the aspects measured include the characteristics of the learning model with an average validity value of 0.71 in the high category, the design of learning activities with an average validity value of 0.83 in the very high category, the stages of the learning model with an average validity value of 0.80 in the very high category, the assumptions of the application of the design with an average validity value of 0.83 in the very high category, and the learning assessment strategy carried out with an average validity value of 0.83 in the very high category. Furthermore, the aspects assessed for the material expert instrument include the formulation of learning objectives with an average validity value of 0.83 in the very high category and the material organization strategy of 0.85 in the very high category. Finally, for the language expert instrument, the aspects measured include straightforwardness with an average validity of 0.78 in the high category, suitability with an average validity of 0.83 in the very high category, suitability with an average validity of 0.92 in the very high category, and rules for using Indonesian spelling with an average validity of 0.63 in the high category.

Next, for quantitative analysis in this study in the form of questionnaire scores obtained from the responses of educators and students to the learning model used. Furthermore, the process of internal and external validity control is carried out to obtain validity in hypothesis testing, so the research design needs to be validated so that the results of this study can be generalized to the population. In addition, the satisfaction of educators and students as users is also considered by filling out a satisfaction questionnaire. In this case, the aspects assessed include satisfaction based on educator responses, which obtained an average of 84.17%

with an interesting category; clarity aspects, with an average of 86.40% in the very interesting category; and interest aspects, with an average of 92.50% with exciting category. Based on the response of student satisfaction, an average of 79.85% satisfaction aspects were obtained in the interesting category, clarity aspects 79.60% interesting category, and interest aspects 79.40% interesting category.

FINDINGS

The materials used in this study contain several aspects of learning: conceptual, principal, procedural, and factual. Concept mastery is students' ability to master and understand a meaning or concept related to known facts and situations (Gotriansyah et al., 2021; Rahmadhani et al., 2021). Mastery of concepts in learning can encourage students to explain material in their sentences and language according to the knowledge gained without changing the meaning (Wijaya et al., 2020). Conceptual aspects of learning are understanding related to understanding, thinking logically, thinking systematically, determining conclusions, assembling a reason, and determining a strategy (Sulianto, 2012).

Procedural knowledge is a standard that underlies various methods or practices used to build scientific knowledge (Rahayu, 2017). Procedural knowledge generally describes how to do something and practices research methods and criteria for using skills, techniques, and methods (Gotriansyah et al., 2021; Siswaningsih et al., 2016). In addition, there is also material with aspects of knowledge about the principles in this study. Knowledge of principles is the knowledge that is dominantly used to study a phenomenon or problem (Julianingsih, 2017). Knowledge related to the principal aspects of learning can be related to laws, rules, formulas, and applicable rules (Nafiati, 2021). Furthermore, the material presented relates to facts in the surrounding environment. Factual knowledge is basic knowledge that students must know to study a scientific discipline to solve problems that occur in that discipline (Rahmadhani et al., 2021). At this design stage, the syntax design of the vocational literacy-based learning model was prepared, as seen in the Table 1.

Based on the Table 1, the provision of Essential Questions in the project-based learning model is synchronized with the dimension of work attitude and knowledge context on the indicator of work preparation in the vocational literacy construct. The stage developed into the stimulation stage as a preliminary activity in the vocational literacy-based learning model. Next, the stage of making a project plan design in the project-based learning model is synchronized with the dimension of work attitude on the indicator of response to technology, the dimension of knowledge mastery on the indicator of work preparation, and the dimension of work attitude on the indicator of work preparation in the construction of vocational literacy. This activity was developed in the exploration stage as a core activity in the syntax of the vocational literacy-based learning model.

Making a schedule in the project-based learning model is synchronized with vocational literacy, namely the dimension of knowledge context in communication indicators, collaboration indicators, and response indicators to the latest technological developments. In addition, the dimension of knowledge mastery is also synchronized, starting from communication competency indicators, collaboration ability indicators, and response indicators to technological developments. From these several dimensions, it is developed into an elaboration stage, also included as the core of learning in the syntax of the vocational literacy-based learning model.

Next, monitoring students and project progress is synchronized with vocational literacy, namely in the dimension of the competency achievement process with indicators of work preparation, response to technological developments, communication skills, and indicators of collaboration skills. Furthermore, it is developed into the realization stage. This stage is still included in the learning core, where students compile products to solve problems contained in worksheets.

As the closing stage of learning in the project-based learning model, assessing results and reflection are synchronized with four dimensions and four constituent indicators in the vocational literacy construct. Then, it was developed into a monitoring and evaluating activity as the closing stage in the syntax of the vocational literacy-based learning model.

Table. 1 Syntax Development of Vocational Literacy-based Learning Model

Project-Based Learning	Vocational Literacy-Based Learning Model (Before Revision)	Vocational Literacy-Based Learning Model (After Revision)
Essential Questions (Giving questions to invite students to do activities**)**	**Stimulation** (opening learning, providing stimulation or triggering (in the form of pre-test, narrative, questions, pictures, videos). It is carried out to find out and build the basic abilities of students related to the material to be delivered)	**Stimulation** (opening learning, conveying learning objectives, providing stimulation or lighting (in the form of pre-test, narrative, questions, pictures, videos). It is carried out to find out and build the basic abilities of students related to the material to be delivered)
Create a project plan design (the project plan is determined by the student, referring to the essential questions given)	**Exploration** (group division for students, giving worksheets). Students explore and use their ability to observe, connect, ask questions, and argue about the project to be designed.	**Exploration** (teachers provide materials, students are divided into groups, and worksheets are provided). Students use their ability to observe, connect, ask, and argue about the project to be designed.
Create a schedule (Educators and Students jointly prepare a schedule of learning activities)	**Elaboration** (Students develop thinking and think flexibly to be able to find solutions or design a product)	**Elaboration** (Students record concepts obtained from exploration activities, develop thinking, and think flexibly through discussions related to concepts related to the material when designing the desired product to solve an existing problem). Students are directed to use the latest technology to complete the project.
Monitor students and project progress (teachers monitor activities during project completion to find out the progress of project implementation and anticipate obstacles faced by students)	**Realization** (Students are directed to make products designed beforehand using a computer or a manual). Teachers accompany and assist in discussions if they experience difficulties.	**Realization** (Students are directed to make products that have been previously designed using computers or manuals.) The teacher accompanies the students to complete the product and helps in the discussion if they experience difficulties.
Assess results (assessments are conducted to set the achievement of standards, evaluate the student's progress, and give feedback)	**Monitoring & Evaluating** (Teachers monitor *realization* activities / guide students in solving problems / discuss product SWOT, and ensure students' work is by learning achievements. Reflecting/*post*ing, as well as learning conclusions with students.)	**Monitoring & Evaluating** (Teachers monitor *realization* activities / guide students in solving problems / discuss product SWOT, and ensure students' work is by learning achievements. Reflecting/*post*ing, as well as concluding learning with students. Teachers provide remedial to students who obtain below-average scores (KKM)
Reflection (reflecting on the results of the project being worked on)	-	-

The learning design expert is the First Expert Learning Technology Developer of the Ministry of Education and Culture of the Republic of Indonesia and the Coordinator of the Centre for Education, Teacher Training, and Women's Studies LPPM State University of Jakarta. Aiken's V formula calculated the results of the expert test conducted by the learning design experts; here is the table of the categorization of validity value using Aiken's V formula:

Table 2. The Categorization of Validity Value

Validity Value	Information
0,00 – 0,19	Very Low Validity
0,20 – 0,39	Low Validity
0,40 – 0,59	Medium Validity
0,60 – 0,79	High Validity
0,80 – 1,00	Very High Validity

From the table of categorization above, an average of 0.80 was obtained for the very high category. The following is a recapitulation of the results of the validation assessment by a learning design expert.

Table 3. Recapitulation of the Results of the Validity of Learning Design Experts

No.	Aspects	Aiken's Validity Value	Information
1	Characteristics of the Learning Model	0,71	High Validity
2	Learning Activity Design	0,83	Very High Validity
3	Stages of the Learning Model	0,80	Very High Validity
4	Assumptions of Design Implementation	0,83	Very High Validity
5	Learning Assessment Strategies Conducted	0,83	Very High Validity
Average total rating		0,80	Very High Validity

The validator's assessment of the aspect of Learning Model Characteristics obtained a validity value of 0.71 in the high category. The aspect of Learning Activity Design obtained a validity value of 0.83 with a very high category, the aspect of Learning Model Stage obtained a validity value of 0.80 with a very high category, the aspect of the Assumption of Design Implementation obtained a validity value of 0.83 with a very high category, and the aspect of the Learning Assessment Strategy Carried out obtained a validity value of 0.83 with a very high category.

Based on the table above, the characteristic aspects of the developed learning model obtained an average score of 0.71 with a high category. The learning model is developed based on the characteristics of the students. The design of learning model activities and the stages of the learning model are oriented to student activities. The assumption of the learning model can be used with an assessment strategy designed by learning competencies. Thus, the assessment results by learning design experts related to the vocational literacy-based learning model can be used for improvements. The following is a summary of learning design experts' validation results and improvements.

In the Table 4, comments and input are provided by learning design experts. Improvements or revisions are made by referring to the comments and suggestions of the learning design expert. The first is related to the planned learning topics, which start with a low level of material, then intermediate, and then increase to a high material category. After implementing the Mid-Semester Exam (UTS), the material will return to a low level; this is done so that students can adjust and study the material to improve in the next intermediate and high material.

Suggestions related to the writing of syntax of vocational literacy-based learning models in the implementation plan of the learning implementation that is prepared. The learning syntax is written on a piece of paper that will be placed on the front page of the learning implementation plan. This is done to avoid syntax (learning steps) that are not done (missed). There are suggestions for adding follow-up learning activities in enrichment or remedial at the closing stage of learning. Based on these suggestions, enrichment or remedial is included in the closing stage of learning, namely monitoring and evaluating. Enrichment or remedial is given to students who get below average on the material presented by giving essay questions or multiple choice related to the material. The expected final ability achievement must be added to the study material/learning objectives according to the lesson plan to be more detailed. Based on these suggestions, the expected ability achievements are written on the first page of the learning implementation plan. The outcomes (learning objectives) are adjusted to the material that the teacher will teach.

Table 4. Results of Validation of Learning Design Experts

Comments, Suggestions, and Improvements	Model Revision
1. The final ability expected in the learning implementation plan is better if the competence is low, medium, or high.	1. The planned learning topics are adjusted to the level of learning materials (low, intermediate, high). After UTS, the topic will return to the low material as an introduction to the intermediate and high material.
2. In the design *of vocational literacy-based* learning activities, the syntax of PJBL should be written	2. The vocational *literacy-based learning model's syntax* is written on the learning implementation plan's first page. This syntax includes five stages: five stages: *stimulation, exploration, elaboration, realization, monitoring, and evaluatio*n.
3. In closing, please add about the follow-up of learning activities in enrichment or remedial.	3. Each teacher can prepare follow-up in the form of remedial or enrichment. Enrichment or remedial is adjusted to the material taught
4. For example, the group assessment rubric is still unclear regarding time.	4. Information on time was added to the group assessment rubric.
5. To be more detailed, the expected achievement of final ability should be added to the study material/learning objectives according to the lesson plan.	5. The expected ability achievement is written on the first page of the learning implementation plan. The outcomes (learning objectives) are adjusted to the material that the teacher will teach.
6. There is no Assessment Rubric (indicators and aspects of assessment) on the Student Assessment Table to assess Job Preparation, Response to Technology, Communication, and Collaboration.	6. The assessment rubric is prepared and attached to the group monitoring sheet.
7. The student worksheet should be made into a column with the answer results of the student's discussion.	7. The student answer result column is created as a student worksheet; the worksheet is attached along with the student worksheet.

The prepared assessment rubric received comments about the lack of clarity in determining the time dimension. Based on these comments, improvements were made by adding detailed information related to the time assessment in the assessment rubric. For example, the assessment on the time aspect is said to be competent if the student can make or collect products/assignments on time (according to the agreed time). Next, it is recommended that an answer column be created for the results of the student discussion on the student worksheet. Based on these suggestions, the answer column is made separately from the student's worksheet. The discussion result sheet will be attached to the student's worksheet. The following are the assessment results regarding the model's feasibility according to the Product Development Eligibility Criteria for Learning Table 5 by (Maulana et al., 2019; Panggabean et al., 2020).

Table 5. Product Development Eligibility Criteria

%	Description
0 – 20	very inappropriate
21 – 40	inappropriate
41 – 60	enough
61 – 80	appropriate
81 – 100	very appropriate

The assessment results of learning design experts provide input, namely that the learning model that has been developed is very feasible to be implemented in learning based on the total average acquisition, which is 84.24 with a very feasible category. This can be seen from the relevance and clarity of the characteristic aspects of the learning model, the relevance and clarity of the learning activity design aspect, the clear stages of the learning model, the assumption of the application of an explicit model design, and the relevance of the learning assessment strategy carried out. These aspects obtained an average score of above 60% (feasible and very feasible categories). The characteristic aspects of the learning model obtained an average score of 77.10% in the feasible category. In comparison, the other four aspects were considered to obtain an average of above 80% in the very feasible category.

According to the table above, here is the Recapitulation of Feasibility Results of Learning Design Experts:

Table 6. Recapitulation of Feasibility Results of Learning Design Experts

No.	Aspects	Average of each aspect (%)	Information
1	Characteristics of the Learning Model	77,10	Proper
2	Learning Activity Design	86,70	Highly Worthy
3	Stages of the Learning Model	84,00	Highly Worthy
4	Assumptions of Design Implementation	86,70	Highly Worthy
5	Learning Assessment Strategies Conducted	86,70	Highly Worthy
	Average total rating	84,24	Highly Worthy

From the assessment results, the experts suggested that learning activities should be arranged to create learning, which shows that teaching and learning activities must be carried out continuously. It is necessary to pay attention to the formulation of the scope and objectives of learning, the use of technology in learning, and the writing system in the syntax of the learning model that has been developed. A questionnaire was distributed to determine the response to applying the vocational literacy-based learning model in the Teaching and learning experiment on construction cost estimation. This activity aims to obtain responses related to satisfaction from teacher participants.

The results of the teacher survey can be used to make decisions related to the feasibility of using a vocational literacy-based learning model in vocational schools. The table below is used as a reference to determine the Learning Model Satisfaction Level Criteria.

Table 7. The Learning Model Satisfaction Level Criteria

No	Validity Criteria	Validation Level Category	Information
1.	85,01% - 100%	Very satisfied/Very interesting/Very effective/ Very thorough/ Very practical	It can be used without revision.
2.	70,01 – 85,00%	Satisfied/Interesting/Effective/Complete/Practical	It can be used with minor/slight revisions
3.	50,01 – 70,00%	Less satisfying/Less enjoyable/Less effective/Less complete/Less practical	It is recommended not to use
4.	0,00 – 50,00%	Not satisfied/Not engaging/Not compelling/Not complete/Not practical	It cannot be used

(D. A. Setiawan et al., 2018)

From the table above, the results of the learning model experiment test in this study obtained satisfaction responses from teachers and students as follows:

Table 8. Recapitulation of Teacher Satisfaction Response

No.	Aspects	Average of each aspect (%)	Information
1	Satisfaction	84,17	It can be used with minor/slight revisions
2	Clarity	86,40	Can be used without revision
3	Ketertarikan	92,50	It can be used without revision
Average total rating		87,69	It can be used without revision

Teachers' satisfaction with the vocational literacy-based learning model obtained a result of 84.17% with an interesting category. For clarity, each stage in the model obtained a result of 86.40% with an exciting category. The data shows that the syntax (stages) of the developed model is arranged and attractive for teachers to implement in learning. Furthermore, interest in the vocational literacy-based learning model was obtained at 92.50%, an exciting category. The aspect of interest obtained the highest score, so it can be

interpreted that teachers from the expertise program sampled in this study are highly interested in applying vocational literacy-based learning.

DISCUSSION

The results of the validity test related to Learning Design in the developed learning model were obtained with an average of 0.80 (very high category) and an average feasibility of 84.24% (very feasible category). From the assessment results by learning design experts, the Characteristics of the Learning Model obtained the lowest validity and feasibility values, namely 0.71 (high category) and 77.10% (feasible category). This value can be interpreted as the characteristics of the learning model developed by the characteristics of the students. However, it is necessary to make revisions related to the lack of elements conveying the scope and learning objectives in the prepared lesson plans and the expected final achievements that need to be adjusted to the planned learning objectives.

The Stages of the Learning Model obtained validation and feasibility results of 0.80 (very high category) and 84 % (very feasible category). The value obtained indicates that this aspect has a systematic learning stage, is easy to understand, has linear stages to realize learning objectives, and has continuity at each stage of its activities. Next, the aspects of Learning Activity Design, Assumptions of Design Implementation, and aspects of the Learning Assessment Strategy Carried out obtained validity and feasibility results of 0.83 (very high category) and 86.70% (very feasible category). From the scores obtained, it can be interpreted that the syntax of the learning model developed has been designed sequentially and in accordance with the standards of the learning implementation process (there are preliminary, core, and closing stages) with a clear learning assessment strategy.

Validity tests were also conducted on the language used in syntax (learning steps) in the vocational literacy-based learning model. Four aspects are assessed; in the straightforward aspect, the validation value obtained is 0.78 (high category) with a feasibility of 82.50% (very feasible). This means that the words in the syntax have been arranged, and the sentence formulation has used effective and standard sentences. In the communicative aspect, the validation value obtained was 0.83 (very high category) and 86.70% (very feasible category) feasibility. The assessment shows that the sentences in the syntax do not have double meanings, are easy to understand, and can describe information clearly.

Furthermore, the suitability aspect obtained a validation value of 0.92 (very high category) with a feasibility of 93.30% (very feasible category). This means that the stimulus/discourse sentences presented describe the intention of the planned project/task, and the sentences in the syntax are based on the development of the students and their emotional development. Next is the aspect of the EBI rule, which obtained the lowest validation value compared to other aspects, namely 0.63 (high category) and a feasibility of 70.00% (high category). This score is given because many grammar errors are used in sentences in syntax (learning steps), punctuation, and sentences that have not used the improved Indonesian spelling.

Based on the assessment results, the project learning model developed based on vocational literacy has a high level of validity and feasibility, so it is feasible to use it in teaching and learning activities at the vocational school level. This model can also be used as a basis for conducting future research to improve the competence of professional lecturers and teachers based on vocational literacy. The syntax of the vocational literacy-based learning model is developed from the learning steps contained in the project-based learning model.

Stimulation

The stimulation stage is a preliminary activity for learning. The teacher opened the learning by greeting, praying, and checking students' attendance. At this stage, the synchronization of vocational literacy with the dimension of work attitude and knowledge context in the work preparation indicators is found in the opening of learning, especially in providing stimulation or lightning. The provision of stimulation or ignition in question is a treatment from the teacher, namely giving a narrative or quiz and then asking students to respond. This activity was carried out to instill an initial understanding of the material to be delivered.

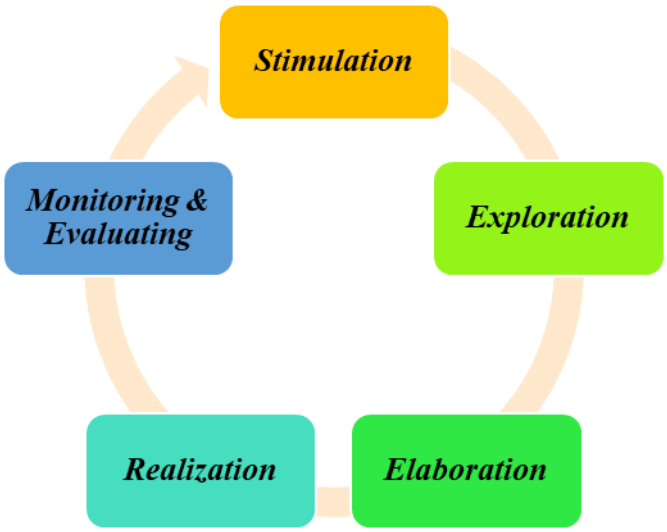

Figure 2. Syntax of Vocational Literacy-Based Learning Model

Exploration

The exploration stage is the beginning of the core learning stage. In this stage, teachers convey learning materials by utilizing PowerPoint media, video broadcasting, or other media to synchronize the work attitude dimension on the indicators of response to technology in the vocational literacy construct. The material presented uses the latest sources from the last 5 years.

In this stage, the synchronization of vocational literacy is also found in the exploration section carried out by students. The teacher divides students into several groups and then gives a worksheet containing assignments according to the material presented. Students can explore the assignment with their group friends. The exploration activities carried out by students are the implementation of the learning stage associated with the dimension of knowledge mastery in the work preparation indicators. The activity aims to build fundamental knowledge related to the material provided so that they can understand the project given on the worksheet.

In addition, exploration activities are also related to implementing the work attitude dimension on the work preparation indicator. The goal is for students to desire to behave and think to complete the project in the worksheet.

Elaboration

The elaboration stage is part of the core stage of learning; at this stage, students develop ideas/ideas/creations to express cognitive concepts in designing product designs. This stage is synchronized with vocational literacy, namely the context dimension of knowledge on communication indicators; the goal is for students to know the possibility of working together in groups. Furthermore, the collaboration indicator aims to make students understand the possibility of group collaboration. In addition, indicators of response to the latest technological developments are also synchronized in this stage to allow students to know the technological devices currently developed for project completion.

The dimension of knowledge mastery is also synchronized, starting from the communication competency indicators, with the goal of students being able to convey thoughts or opinions related to the material provided. Furthermore, the indicator of collaboration ability is intended so students can establish group cooperation. Then, the indicator of response to technological developments is intended so that students understand the technological devices that are developing today to be applied or used in completing projects in worksheets. The teacher assists with the discussion activities and helps the student if he experiences difficulties during the discussion.

Realization

The realization stage is still included in the core of learning. Product design realization activities are synchronized with vocational literacy, namely in the dimension of the competency achievement process. The first indicator is work preparation, intended so that students have skills based on the material provided by the teacher. Next is the indicator of response to technological developments; students are expected to operate the latest technology that suits their needs in solving products or problems. Furthermore, communication skills aim to give students a valuable role or task in the group to complete a product or project on a worksheet. Then, the indicator of collaboration skills aims to enable students to work together professionally in groups. The product prepared by the students is an effort to solve the problems in the worksheet. At this stage, the teacher also assists students; the teacher can also help students experiencing difficulties in realization activities.

Monitoring & Evaluating

The monitoring and evaluation stage is the closing stage in vocational literacy-based learning. The teacher implements this stage, ensuring that the learning activities carried out by the students follow the planned learning objectives; the teacher also monitors the student's work. Closing activities in vocational literacy-based learning are synchronized with vocational literacy, especially in the monitoring section. Teachers monitor learning targets that have been achieved and activities or things that arise during learning. Recording is carried out by utilizing group monitoring sheets and student monitoring sheets. The monitoring sheet teachers use is equipped with an assessment rubric to make it easier for teachers. However, the prepared assessment rubric emphasizes the assessment of indicators contained in the vocational literacy construct, namely indicators of job preparation, response to technological developments, communication skills, and collaboration skills. At this stage, the teacher also reflects that learning reflection activities can be carried out with students at the end of learning. Teachers can also provide an intro to the learning topic that will be given at the upcoming meeting on authentic learning.

Based on the findings of this study, there are sustainable opportunities with significant potential impact on education, particularly in the field of vocational training, in the future. With its high levels of validity and feasibility, this model can be identified as an essential innovation supporting the advancement of 21st-century education. In the context of vocational education, strengthening vocational competencies for vocational high school (SMK) students can be optimized through strategically designed learning processes, utilizing syntax tailored to vocational education's specific needs and characteristics (Akhyar et al., 2024). This approach provides students with learning experiences that focus on practical skills, enabling them to not only master competencies relevant to the workforce and industry but also to develop familiarity and confidence in applying these skills in real-world contexts (Ranto et al., 2024). Moreover, this model promotes a more factual and inspiring learning approach, producing graduates who are job-ready and adaptable to the dynamic challenges of a globalized world. This positions the vocational literacy-based learning model as a crucial tool for driving progressive and progressive educational transformation with future demands (A. Setiawan et al., 2023).

The findings of this study serve as a foundational basis for designing future curricula that align more closely with the demands of the job market and the global community (Suyitno et al., 2023). A curriculum grounded in vocational literacy offers a strategic avenue to bridge the gap between education and industry, fostering graduates with high levels of national and international competitiveness. Moreover, this learning model presents valuable opportunities for further investigation, including evaluating its effectiveness across diverse educational settings or expanding its application to other project-based learning frameworks. This model can be a benchmark for developing more inclusive and sustainable educational innovations supported by strong validation and feasibility outcomes. In summary, the vocational literacy-based learning model provides a holistic approach to advancing vocational education by enhancing the quality of learning for current and future generations (Nurjanah et al., 2022). When implemented effectively, it can serve as a cornerstone for cultivating a skilled, capable generation equipped to navigate global challenges while laying the groundwork for a more adaptive, relevant, and forward-thinking transformation in education.

CONCLUSION

Based on the analysis and discussion results, the vocational literacy-based learning model developed has been validated and considered feasible for the dissemination or implementation stage of learning. The dissemination stage can be done through experiments or classroom action research (PTK). The syntax developed has been adjusted to the characteristics of subjects and competencies in vocational schools that prioritize practice, projects, and portfolios. Therefore, this vocational literacy-based learning model is expected to solve some learning problems in vocational and vocational schools in Indonesia.

ACKNOWLEDGMENT

The authors would like to thank our funding supporters, Kementerian Pendidikan Tinggi and DIPA LPPM UNJ. They would also like to thank Postgraduate UNJ, FT UNJ, SMKN 1 Jakarta, and SMKN 56 Jakarta for their support and facilities.

REFERENCES

Akhyar, M., Ihsan, F., Suharno, S., Tamrin, A., & Purwanto, P. (2024). Development of problem and project-based learning syntax to improve vocational student learning outcomes. *Jurnal Pendidikan Teknologi Dan Kejuruan*, *30*(1), 01–19. https://doi.org/10.21831/jptk.v30i1.53968

Anggraeni, P., & Akbar, A. (2018). Kesesuaian Rencana Pelaksanaan Pembelajaran dan Proses Pembelajaran. *Jurnal Pesona Dasar*, *6*(2). https://doi.org/10.24815/pear.v6i2.12197

Anggraini, P. D., & Wulandari, S. S. (2020). Analisis Penggunaan Model Pembelajaran Project Based Learning Dalam Peningkatan Keaktifan Siswa. *Jurnal Pendidikan Administrasi Perkantoran (JPAP)*, *9*(2), 292–299. https://doi.org/10.26740/jpap.v9n2.p292-299

Ariga, S. (2023). Implementasi Kurikulum Merdeka Pasca Pandemi Covid-19. *Edu Society: Jurnal Pendidikan, Ilmu Sosial Dan Pengabdian Kepada Masyarakat*, *2*(2), 662–670. https://doi.org/10.56832/edu.v2i2.225

Arthur, R., Daryati, Maulana, A., Febiansyah, R., & Kidung, K. (2021). Scientific literacy of vocational school students in building construction. *Journal of Physics: Conference Series*, *1833*(1), 012036. https://doi.org/10.1088/1742-6596/1833/1/012036

Arthur, R., Luthfiyah, F., Maulana, A., & Maharani, S. (2023). *The development and validation of theoretical model vocational literacy*. 030006. https://doi.org/10.1063/5.0147993

Arthur, R., Maharani, S., Maulana, A., & Marzuq, A. (2023a). *Vocational literacy: A new paradigm of vocational education and training (VET) in Indonesia*. 110003. https://doi.org/10.1063/5.0105750

Binkley, M., Erstad, O., Herman, J., Raizen, S., Ripley, M., Miller-Ricci, M., & Rumble, M. (2012). *Assessment and Teaching of 21st Century Skills* (Vol. 9789400723). Springer Science and Business Media LLC. https://doi.org/10.1007/978-94-007-2324-5

Deutscher, V., & Winther, E. (2018). Instructional sensitivity in vocational education. *Learning and Instruction*, *53*, 21–33. https://doi.org/10.1016/j.learninstruc.2017.07.004

Direktorat Jenderal Pendidikan Vokasi. (2022). *Rencana Strategi Direktorat Jenderal Pendidikan Vokasi Tahun 2020 - 2024* (D. J. P. Vokasi, Ed.; Revisi). Kementrian Pendidikan, Kebudayaan, Riset Dan Teknologi.

Dwita, L., & Susanah. (2020). Penerapan Pendekatan Science, Technology, Engineering, And Mathematics (STEM) Dalam Pembelajaran Matematika Di Smk Pada Jurusan Bisnis Konstruksi Dan Properti. *MATHEdunesa: Jurnal Ilmiah Pendidikan Matematika*, *9*(2), 276–286.

Estriyanto, Y., Kersten, S., Pardjono, P., & Sofyan, H. (2017). The missing productive vocational high school teacher competency standard in the Indonesian education system. *Journal of Technical Education and Training*, *9*(1), 26–44.

Ewing, B. (2017). An exploration of assessment approaches in a vocational and education training courses in Australia. *Empirical Research in Vocational Education and Training*, *9*(1), 14. https://doi.org/10.1186/s40461-017-0058-z

Ferm, L. (2021). Vocational Students' Ways of Handling the Academic/Vocational Divide. *International Journal for Research in Vocational Education and Training*, *8*(1). https://doi.org/10.13152/IJRVET.8.1.1

Furi, L. M. I., Handayani, S., & Maharani, S. (2018). Eksperimen Model Pembelajaran Project Based Learning Dan Project Based Learning Terintegrasi Stem Untuk Mengingkatkan Hasil Belajar Dan Kreativitas Siswa Pada Kompetensi Dasar Teknologi Pengolahan Susu. *Jurnal Penelitian Pendidikan*, *35*(1), 49–60.

Gotriansyah, K., Dalifah, D., & Winarni, E. W. (2021). Analisis Buku Tematik Siswa Muatan IPA Ditinjau Dari Dimensi Pengetahuan Faktual, Konseptual, Prosedural dan Metakognisi (Studi Deskriptif Materi IPA Tema 6 Dan 7 Kelas VI SD). *Juridikdas: Jurnal Riset Pendidikan Dasar*, *4*(3), 349–362.

Hadi, A., Robianto, R., Gusrion, D., Andrianof, H., & Putra, O. A. (2021). Model Blended Learning pada Pendidikan Vokasi Berbasis Pembelajaran Terpadu. *Jurnal KomtekInfo*, *8*(2), 134–139. https://doi.org/10.35134/komtekinfo.v8i2.108

Haug, B. S., & Mork, S. M. (2021). Taking 21st-century skills from vision to classroom: What teachers highlight as supportive professional development in the light of new demands from educational reforms. *Teaching and Teacher Education*, *100*, 103286. https://doi.org/10.1016/j.tate.2021.103286

Hazmi, N. (2019). Tugas Guru dalam Proses Pembelajaran. *Journal of Education and Instruction (JOEAI)*, *2*(1), 56–65. https://doi.org/10.31539/joeai.v2i1.734

Heinze, A., Arend, J., Gruessing, M., & Lipowsky, F. (2018). Instructional approaches to foster third graders' adaptive use of strategies: an experimental study on the effects of two learning environments on multi-digit addition and subtraction. *Instructional Science*, *46*(6), 869–891. https://doi.org/10.1007/s11251-018-9457-1

Herawati, Lamada, M., & Rahman, E. S. (2019). *Analisis Kemampuan Literasi Siswa SMK Negeri di Kota Makassar*. Universitas Negeri Makassar.

Inderanata, R. N., & Sukardi, T. (2023). Investigation study of integrated vocational guidance on work readiness of mechanical engineering vocational school students. *Heliyon*, *9*(2), e13333. https://doi.org/10.1016/j.heliyon.2023.e13333

Jauzy, M. H. Al, Hendi, P., & Ilham, R. (2024). Implementasi Manajemen Evaluasi dalam Kurikulum Merdeka di SMK Muhammadiyah Delanggu. *Jurnal Pendidikan dan Ilmu Sosial (JUPENDIS)*, *2*(2), 86–95. https://doi.org/10.54066/jupendis.v2i2.1484

Julianingsih, S. (2017). *Pengembangan Instrumen Asesmen Higher Order Thingking Skill (HOTS) Untuk Mengukur Dimensi Pengetahuan IPA Siswa Di SMP*. Universitas Lampung.

Khoirurrijal, Fadriati, Sofia, Makrufi, A. D., Gandi, S., Muin, A., Tajeri, Fakhrudin, A., Hamdani, & Suprapno. (2022). *Pengembangan Kurikulum Merdeka*. CV. Literasi Nusantara Abadi.

Krötz, M., & Deutscher, V. (2021). Differences in Perception Matter – How Differences in the Perception of Training Quality of Trainees and Trainers Affect Drop-Out in VET. *Vocations and Learning*, *14*(3), 369–409. https://doi.org/10.1007/s12186-021-09263-7

Lutfiana, D. (2022). Penerapan Kurikulum Merdeka dalam Pembelajaran Matematika SMK Diponegoro Banyuputih. *VOCATIONAL: Jurnal Inovasi Pendidikan Kejuruan*, *2*(4), 310–319. https://doi.org/10.51878/vocational.v2i4.1752

Maharani, S., Arthur, R., & Maulana, A. (2023). The Bibliometrics Analysis of Literacy of Vocational High School Student In Building Construction Expertise. *Jurnal PenSil*, *12*(2), 207–221. https://doi.org/10.21009/jpensil.v12i2.33687

Maulana, A., Puspita, A. J., Pangastuti, K. K., Daryati, D., & Arthur, R. (2022). The Concept of Literacy Vocational-Based E-Module of Technical Mechanical Subject. *Journal of Physics: Conference Series*, *2377*(1), 012068. https://doi.org/10.1088/1742-6596/2377/1/012068

Maulana, A., Sekartaji, G. T., Arthur, R., & Dewi, L. K. (2019). Pengembangan Media Video Presentasi Pada Mata Kuliah Hidrologi di Universitas Negeri Jakarta. *Kwangsan: Jurnal Teknologi Pendidikan*, *7*(2), 170. https://doi.org/10.31800/jtp.kw.v7n2.p170--183

Melles, G., Winfree, T., & Graham, P. (2019). *Collaborative Design of Mobile Interfaces for Vocational Building and Construction Education* (pp. 641–651). https://doi.org/10.1007/978-981-13-5974-3_56

Mulyadi, E. (2016). Penerapan Model Project Based Learning untuk Meningkatan Kinerja dan Prestasi Belajar Fisika Siswa SMK. *Jurnal Pendidikan Teknologi Dan Kejuruan*, *22*(4), 385. https://doi.org/10.21831/jptk.v22i4.7836

Nadir, M., Arthur, R., & Daryati, D. (2022). Literature Review: The Role Of E-Modules in Improving Vocational Students' Scientific Literacy Skills. *Jurnal PenSil*, *11*(3), 197–205. https://doi.org/10.21009/jpensil.v11i3.28673

Nafiati, D. A. (2021). Revisi taksonomi Bloom: Kognitif, afektif, dan psikomotorik. *Humanika*, *21*(2), 151–172. https://doi.org/10.21831/hum.v21i2.29252

Nurjanah, I., Ana, A., & Masek, A. Bin. (2022). Work readiness of vocational high school graduates in facing the industrial 4.0 era. *Jurnal Pendidikan Teknologi Dan Kejuruan*, *28*(2). https://doi.org/10.21831/jptk.v28i2.48552

Panggabean, N. H., Amir, D., & Nadriyah. (2020). Pengembangan Bahan Ajar Berbasis Mind Mapping Pada Pembelajaran IPA Tema Lingkungan Sahabat Kita. *Jurnal Tunas Bangsa*, *7*(2), 204–218. https://doi.org/10.46244/tunasbangsa.v7i2.1177

Rahayu, S. (2017). Mengoptimalkan Aspek Literasi Dalam Pembelajaran Kimia Abad 21. *Prosiding Seminar Nasional Kimia UNY 2017 : Sinergi Penelitian Dan Pembelajaran Untuk Mendukung Pengembangan Literasi Kimia Pada Era Global*, 1–16.

Rahmadhani, Y., Koto, I. K., & Winarni, E. W. (2021). Analisis Kualitas Butir Soal Ujian Sekolah Mata Pelajaran IPA Berdasarkan Dimensi Pengetahuan Faktual dan Konseptual Ditinjau Dari Konten dan Konteks. *Jurnal Pembelajaran Dan Pengajaran Pendidikan Dasar*, *4*(1), 1–12. https://doi.org/10.33369/dikdas.v4i1.14213

Ranto, R., Wulandari, A., & Rohman, N. (2024). Implementation of flipped learning to increase student learning activeness in the combustion engine lecture. *Jurnal Pendidikan Vokasi*, *14*(2). https://doi.org/10.21831/jpv.v14i2.66010

Rohr-Mentele, S., & Forster-Heinzer, S. (2021). Practical validation framework for competence measurement in VET: a validation study of an instrument for measuring basic commercial knowledge and skills in Switzerland. *Empirical Research in Vocational Education and Training*, *13*(1), 18. https://doi.org/10.1186/s40461-021-00122-2

Rouf, F. A., Arthur, R., Daryati, & Maulana, A. (2021). *Prototype of Science Literacy Instruments on the Competence of Construction and Property Technology Expertise*. https://doi.org/10.2991/assehr.k.210305.096

Salzmann, P., Berweger, S., & Ark, T. K. (2018). Apprentices' Affective Occupational Commitment During Vocational Education and Training. *Journal of Career Development*, *45*(4), 315–329. https://doi.org/10.1177/0894845317696806

Schneider, S., Beege, M., Nebel, S., & Rey, G. D. (2018). A meta-analysis of how signaling affects learning with media. *Educational Research Review*, *23*, 1–24. https://doi.org/10.1016/j.edurev.2017.11.001

Setiawan, A., Andrian, D., Dardjito, H., Yuldashev, A. A., Murlianti, S., Khairas, E. E., Handoko, L., & As'ad, I. (2023). The impact of Indonesia's decentralized education on vocational skills and economic improvement of students. *Jurnal Pendidikan Vokasi*, *13*(3), 246–261. https://doi.org/10.21831/jpv.v13i3.68026

Setiawan, D. A., Wahjoedi, & Towaf, S. M. (2018). Multimedia Interaktif Buku Digital 3D. *Jurnal Pendidikan*, 1133–1141.

Siswaningsih, W., Nahadi, N., & Kusuma, D. C. (2016). Pengembangan Tes Pilihan Ganda Piktorial Untuk Mengukur Penguasaan Pengetahuan Faktual, Konseptual, Dan Prosedural Siswa SMA Pada Materi Kelarutan Dan Hasil Kali Kelarutan. *Jurnal Penelitian Pendidikan Kimia: Kajian Hasil Penelitian Pendidikan Kimia*, *3*(2), 118–129.

Sulianto, J. (2012). Keefektifan Model Pembelajaran Kontekstual Dengan Pendekatan Open Ended Dalam Aspek Penalaran Dan Pemecahan Masalah Pada Materi Segitiga di Kelas VII. *PYTHAGORAS Jurnal Pendidikan Matematika*, *5*(2). https://doi.org/10.21831/pg.v5i2.547

Suyitno, S., Jatmoko, D., Primartadi, A., & Ab-Latif, Z. (2023). Industrial practice platform based on work-based learning: A solution to improve student competence. *Jurnal Pendidikan Vokasi*, *13*(1), 98–106. https://doi.org/10.21831/jpv.v13i1.54589

Tusiime, W. E., Johannesen, M., & Gudmundsdottir, G. B. (2022). Teaching art and design in a digital age: challenges facing Ugandan teacher educators. *Journal of Vocational Education & Training*, *74*(4), 554–574. https://doi.org/10.1080/13636820.2020.1786439

Ulum, M., & Ismanto, B. (2017). Strategi Peningkatan Mutu Sekolah Penengah Kejuruan Pasca Penerapan Sistem Manajemen Mutu ISO 9001 : 2008. *Jurnal Pendidikan Ilmu Sosial*, *27*(1), 69–91.

Wahyu, R. (2016). Implementasi Model Project Based Learning (PJBL) Ditinjau dari Penerapan Kurikulum 2013. *Teknoscienza*, *1*(1), 50–62.

Wannapiroon, P., Nilsook, P., Techakosit, S., & Kamkhuntod, S. (2021). STEM Literacy of Students in Vocational Education. *International Journal of Technology in Education and Science*, *5*(4), 527–549. https://doi.org/10.46328/ijtes.253

Wijaya, L. T. T., Jamaluddin, J., & Hadiprayitno, G. (2020). Penguasaan Konsep Sains Peserta Didik SMP Berdasarkan Dimensi Proses Kognitif dan Dimensi Pengetahuan. *Jurnal Pijar Mipa*, *15*(4), 357–361. https://doi.org/10.29303/jpm.v15i4.1912

Wijayanto, T., Supriadi, B., & Nuraini, L. (2020). Pengaruh Model Pembelajaran Project Based Learning Dengan Pendekatan STEM Terhadap Hasil Belajar siswa SMA. *Jurnal pembelajaran fisika*, *9*(3), 113. https://doi.org/10.19184/jpf.v9i3.18561

Yang, Y.-T. C. (2015). Virtual CEOs: A blended approach to digital gaming for enhancing higher order thinking and academic achievement among vocational high school students. *Computers & Education*, *81*, 281–295. https://doi.org/10.1016/j.compedu.2014.10.004