Analysis of The Implementation of HOTS-Based Learning in Vocational High Schools

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**Abstract**—High Order Thinking Skills (HOTS) based learning has been implemented in Vocational High Schools in Indonesia, however, the critical and creative thinking skills of students are still low. Therefore, this research aims to analyze the implementation of HOTS-based learning in vocational high schools. The analysis is important to reveal the causes of the low ability of students to think critically and creatively. Moreover, it was carried out through planning, implementation, and assessment of the learning process. The research design was mixed and the population consisted of vocational high school teachers and students. Purposive sampling was chosen due to the effectiveness of the data collected, which were based on the planning, implementation, and assessment of the learning process. The data was then analysed using descriptive statistical techniques. The results showed that the HOTS-based learning has been implemented, however, it has not been effective, as evidenced by its incomplete application in schools. Furthermore, teaching practice was already HOTS-based, however, it was not planned. The results also showed that learning assessment was based on content, although it did not refer to the lesson plan. Finally, the teachers were still confused about the planning, implementation, and assessment of HOTS-based learning, thus, they needed intensive guidance.

*Index Terms*—HOTS, Learning, Thinking skills and creativity, Vocational school

# Introduction

Based on a comprehensive evaluation of HOTS-based learning programs, it was discovered that teachers performance in HOTS-based teaching practices was still low due to their low knowledge on the learning process. The low knowledge makes it difficult for to them to implement the programs [1]. Moreover, the knowledge referred to herein includes 4 dimensions, namely factual, conceptual, procedural, and metacognitive [2], and it is important for teachers to understand each dimension.

The use of information technology in the learning process is still insufficient, and teachers' knowledge about HOTS learning is not clear. According to [3] Technological advances change lifestyles due to significant digital technology interactions, and this means that soft skills are important [4]. Digital transformation brings about effective and efficient information services [5]. Moreover, the use of the social media and various networks has increased [6], and all fields currently have received the support of technological sophistication [7]. Speed has become the instructional modality of society in this century [8]. Innovation and knowledge networks now interact with each other [9], and the dynamic interactions between people, context, and changing times form the basis for a sustainable career [10]. Finally, the world economy demands continuous innovation in processes, products, and services [11].

A country's economic growth becomes competitive when graduates are able to adapt to technological advances and have generic skills [12]. Moreover, critical, creative, collaborative, and communicative (4C) thinking is a generic skill that is appropriate for the 21st century [11] and [13]. Finally, 4C and self-management skills are skills [14] that are most frequently requested for in job advertisements [15].

Currently, Vocational High School graduates in Indonesia have a negative stigma because they are said to be incompetent [16]. Moreover, the ability to develop the creativity and critical thinking of vocational high school students is not optimal. Most students are only able to work on questions with answers that are easily found in books and are not successful when working on questions that require a higher imagination. This condition is certainly below the expectations of the governments because they programmed high-order thinking skills (HOTS)-based learning and made it compulsory for all schools.

The students feel that their competency level is not compatible with the demands of 21st-century jobs [17]. This is because it has decreased due to the unclear and imprecise vision in the developing curriculum, textbooks, and instructional approach [17]. Some of these uncertainties prompted the government to conduct a study to determine the ability of teachers to implement HOTS-based learning programs.

In the 21st century era, students need 4C skills in generating ideas, analyzing, and creating valuable products [18]. Furthermore, vocational learning requires critical and creative reasoning because many materials require detailed understanding and accurate analysis [19]. Therefore, the teacher needs to change the learning approach from LOT to HOT [20], because this approach is able to stimulate student’s 4C skills [13], [21], [22]. HOTS-based learning activities could effectively improve 4C skills [13], [21], [22] as they enable students to process knowledge that supports direct interaction [23]. Based on this background, the following research questions were formulated:

1. How are the skills of teachers in constructing a HOTS-based instructional design?
2. How are the skills of teachers in the HOTS-based teaching experience?
3. How are the skills of teachers in evaluating HOTS-based learning?

# Literature review

Cornford [24] stated that vocational education is an effective instrument as a workforce creator. Furthermore, it is defined as education with special characteristics that involve various types of work at every level [25] - [27]. To realize the goals of vocational education, the strategy needs to be good [28] and [29]. This type of education also manages effectively and efficiently various resources, technology, and education such as the corporate dimension [29]. Additionally, it teaches not only science, however, also skills [30]. According to Rupert Evans [31], vocational education is part of the education system that prepares a person to be better able to work in a certain job. In general, it includes agriculture, business, distribution, health, household economics, trade, and industry [26].

The curriculum and learning process are key factors for the success of education and would be effective when driven by labor market demands and mutual interactions [16]. Moreover, the neglected interaction between education and the labor market creates policies that cannot solve the problem of surplus labor [32]. Concepts such as link and match have not been implemented integrally and comprehensively because the industry is not ready, therefore, reluctant to collaborate with Vocational High Schools consistently [16]. Knowledge, skills, behavior, and personal traits influence learning in vocational schools [33]. This is because the characteristic of vocational learning is to learn the theory that could be applied in practice [34]. Therefore, work/project-based learning is recommended for vocational learning [35] and [36]. This learning could then significantly increase students' HOTS [13] and [37] which is needed in the 21st century [20], [21], [38], and [39].

Schleicher [40] described the way teachers face the 21st century. It was stated that they need to have high expectations and improve technological abilities to manage the teaching process [40]. MOODLE and Edmodo are good learning management systems for teachers [41]. Moreover, learning in this century requires an interactive culture in the classroom in order that students could participate actively [40]. When teachers are still teaching using a one-way system, students do not have the opportunity to develop activeness in the classroom [42]. Therefore, it is important for teachers to have professional competence in teaching in order to strengthen trust, transparency, autonomy, and a collaborative culture [40]. These characteristics make them become productive in teaching and conduct research to develop their competence [43].

The consistent application of creative and innovative methods would make learning superior [44]. Teachers also need to promote learning innovation inside and outside schools in order to discover more effective ways to scale and spread the innovation [40]. Vocational education shifts the focus from competency achievement to progressive skill development with demands for flexibility, innovation, and excellence in teaching [34]. The innovation could be an extension of the revolution in PISA (Programme for International Student Assessment) [40]. Finally, to increase teaching innovation and learning activities, knowledge management is very important [45].

To improve knowledge management, especially in classroom learning, the education system in Indonesia has been refined by emphasizing the formation of higher-order thinking skills (HOTS) [46]. The mini-site has been implemented in 2016 and is regularly evaluated. Based on Bloom's revised taxonomy, HOTS learning indicators are characterized by mastery of thinking at the level of analyzing (C4), evaluating (C5), and creating (C6) [2], [47], and [48].

According to Wilson [48], an explanation of each revised bloom taxonomic level is shown in Table I below.

## TABLE I: Explanation of the revised bloom taxonomy levels

|  |  |  |  |
| --- | --- | --- | --- |
| **Cognitive Process** | | | **Definition** |
| C1 | LOTS | Observing | Taking relevant knowledge from memory |
| C2 | Understanding | Constructing meaning from the learning process, including oral, written, and pictorial communication |
| C3 | Implementing/ Applying | Performing or using procedures in unusual situations |
| C4 | HOTS | Analyzing | Breaking the material down into its parts and determining how the parts are connected between the parts and to the overall structure or purpose |
| C5 | Assessing/ Evaluating | Making considerations based on criteria or standards |
| C6 | Creating | Putting elements together to form a coherent or functional whole, by rearranging the elements into a new pattern or structure. |

# Method

This research uses mixed methods, and the design used is embedded by placing a data set to support other types of data [49]. The embedded design supports the debate that could achieve convergence of viewpoints [50]. Furthermore, it could be optimized to fulfill various types of constraints, such as performance, time, power, and cost [51].

To answer the first research question, the method used was chosen to test the vocational high school teachers' knowledge of HOTS-based learning and to analyze the instructional design documents that have been designed. The teachers’ knowledge were tested using knowledge dimension indicators based on Bloom's concept, which has been revised by Anderson (2001) and Krathwohl (2002).

An instructional design analysis uses a thinking process at the HOTS level. Questionnaires were used as a tool to test the teachers’ knowledge while documentation and interviews were used to analyze instructional design documents. Finally, the questionnaire results were analyzed descriptively using SPSS 25 software.

To answer question number two, observations were made on the implementation of learning, based on the instructional design that was created. Indicators of teacher success in the teaching experience were measured based on a learning process that could stimulate critical and creative learning. Finally, the thinking process at the HOTS level was used as a reference for observation.

To answer question three, an analysis of the learning evaluation instrument and its implementation was carried out. Meanwhile, instructional design analysis and learning evaluation refer to the thinking process based on Bloom's Taxonomy levels C4, C5, and C6.

The population in this research was teachers of State Vocational High Schools in the field of technology and engineering. Of this population, a total of 115 respondents were then selected using a purposive sampling technique. Data were obtained through observation, interviews, documentation, and questionnaires, and were analysed using descriptive statistical techniques with the help of SPSS 25 software. Finally, for the perception categories refer to Table II below.

## TABLE II: The calculation results of the implementation statement interval

|  |  |  |
| --- | --- | --- |
| **No** | **Perception Index Interval** | **Implementation statement** |
| 1 | 1.00 – 1.75 | Very less |
| 2 | 1.76 – 2.51 | Less |
| 3 | 2.52 – 3.27 | Good |
| 4 | 3.28 – 4.00 | Very good |

The limitation of this research was in the analysis of the learning implementation process that did not use classroom observation techniques because the students were studying at home due to the Covid-19 pandemic. Due to this condition, observations were made through the implementation of online learning. However, observations of the learning implementation process was still carried out following the standards set by the government.

# Result

## The teachers’ skills in constructing a HOTS-based instructional design

This research question had 2 answers namely measuring teacher knowledge and analyzing HOTS-based instructional design.

*Teachers' knowledge about HOTS-based learning*, data on the knowledge of the teachers were obtained through a questionnaire. Furthermore, knowledge dimension indicators which include factual, conceptual, procedural, and metacognitive [52], [53] were used to measure teacher knowledge. The results are shown in Table III below.

## TABLE III: Descriptive Statistics SPSS 25

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **N** | **Minimum** | **Maximum** | **Mean** | **Std. Deviation** |
| Instructional design | 115 | 1.67 | 3.83 | 3.2362 | 0.35285 |
| Factual | 115 | 1.67 | 4.00 | 2.8986 | 0.50180 |
| Konseptual | 115 | 1.67 | 3.67 | 3.0087 | 0.43810 |
| Prosedural | 115 | 1.00 | 4.00 | 3.4087 | 0.74805 |
| Metakognitif | 115 | 2.00 | 4.00 | 3.6290 | 0.42980 |
| Valid N (listwise) | 115 |  |  |  |  |

In the instructional design aspect, the minimum value was 1.67, while the maximum was 3.83. Moreover, the value interval showed that the respondents fell into all categories. Table IV shows the analysis results of the instructional design questionnaire.

## TABLE IV: The analysis results of the instructional design questionnaire

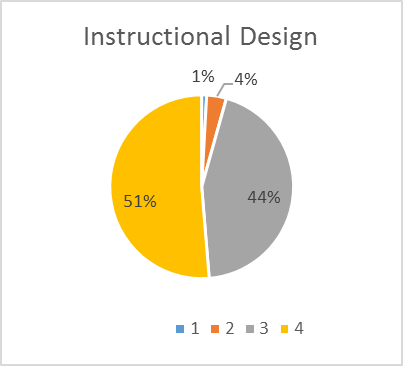
|  |  |  |  |
| --- | --- | --- | --- |
| **No** | **Criteria** | **The achievement level interval** | **Category** |
| 1 | Instructional design | 3.2362 | Good |
| 2 | Factual | 2.8986 | Good |
| 3 | Conceptual | 3.0087 | Good |
| 4 | Procedural | 3.4087 | Very good |
| 5 | Metacognitive | 3.6290 | Very good |

The analysis results showed the number 3.2362 which means that the teachers had good skills in planning based on HOTS. Moreover, the analysis of each item on the instructional design questionnaire is shown in table V.

## TABLE V: Questionnaire items on instructional design

|  |  |  |
| --- | --- | --- |
| **Questionnaire items** | | **Analysis** |
| Dimension | Factual | Introduction, implementation, and the basis of the HOTS Lesson Plan |
| Conceptual | Understanding, Operational Verbs (KKO), learning models, and examples of questions that fall into the HOTS category |
| Procedural | Teachers' skills in planning a HOTS-based instructional design |
| Metacognitive | Methods for handling students' passive attitudes, and the impact of implementing HOTS basis |

The following is a diagram showing the quantity of a HOTS based instructional design.



1. Instructional design diagram

The instructional design diagram is a description of the percentage of combined data results between the factual, conceptual, procedural, and metacognitive dimensions. The interpretation of the diagram is described in table VI.

## TABLE VI: Interpretation of the instructional design diagram

|  |  |  |
| --- | --- | --- |
| **Score** | **Percentage** | **Interpretation** |
| 1 | 1% | Instructional design has not used HOTS KKO therefore, the students' abilities could not reach 4C |
| 2 | 4% | The teacher introduced the HOTS basis in instructional design therefore, the students began to adapt to achieve 4C |
| 3 | 44% | HOTS basis was now being applied frequently in instructional design, hence students were familiar with 4C |
| 4 | 51% | The teachers always implemented HOTS basis in instructional design therefore, the students gained 4C skills |

*Instructional design analysis,* the analysis was carried out on the instructional design documents for one semester. The aspects analyzed include learning models, competencies, and learning indicators. Moreover, the analysis referred to the revised edition of the KKO (Bloom taxonomy action verb) [48] and [52]. Table VII shows the analysis results of the instructional design.

## TABLE VII: Analysis of the instructional design document.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Learning** | | **Competency** | | **Indicators of Competency Achievement** | |
| **Model** | **Behavior** | **HOTS** | **LOTS** | **HOTS** | **LOTS** |
| Problem Based Learning and Project Based Learning | Student | 0% | 100% | 5% | 95% |
| Problem Based Learning | Student | 67% | 33% | 17% | 83% |
| Discovery Learning, Project Based Learning, and Problem Based Learning | Student | 21% | 79% | 22% | 78% |
| Inquiry Learning | Student | 29% | 71% | 20% | 80% |
| Discovery Learning, Project Based Learning, and Problem Based Learning | Student | 73% | 27% | 73% | 27% |
| Discovery Learning | Student | 25% | 75% | 0% | 100% |
| Average of analysis document items | Student | 36% | 64% | 23% | 77% |
| Average percentage of HOTS KKO | | | | | 29.5% |
| Average percentage of LOTS KKO | | | | | 70.5% |

Table VII shows the learning model used by the teachers, namely Discovery Learning, Project Based Learning, Problem Based Learning, and Inquiry. Furthermore, the model shows active student involvement (student-centered learning). Student involvement as a center is directly related to proactive personality [54]. This is because cooperation, support, and sustainability could improve the quality of learning [55]. The high-quality instructional design produces learning outcomes using Bloom's taxonomy action verb at the HOTS level. Moreover, its analysis showed that Bloom's taxonomy action verb at the LOTS level still dominated. In the 6 documents analyzed, it could be seen that the comparison of LOTS and HOTS is 4: 2 for competency and 5: 1 for competency achievement. The preparation of the instructional design has not fully paid attention to the suitability of the action verb. Finally, some teachers stated that the design is made only as a complement to teaching administration.

## Teacher skills in HOTS-based teaching experience

The answers to this question are divided into the experiences and skills of the teachers in HOTS-based teaching.

*Teachers' experiences* in *HOTS-based teaching,* the pandemic in 2019 changed all structures of life, including the learning system, which turned into distance learning (PJJ) [56] - [58]. Prior to the pandemic, face-to-face learning systems carried out theoretical learning in classrooms and practicum, although some had started using online media [59]. Learning via google classroom and Edmodo facilitates students that are carrying out Industrial Work Practices. There is also a quiz game application that evaluates student learning and even schools that have started carrying out Mid-Semester Assessments using online systems.

Before the pandemic, a mixture of face-to-face and online learning was a new thing for students. Modification of face-to-face learning with online learning makes students enthusiastic. This type of learning shows *that* the teacher wants the students to have 4C skills. Meanwhile, with these skills, when given an assignment, students think critically to solve the problems. They also communicate and collaborate with each other to find solutions, even though the teacher does not ask them to do that. Some students would also be motivated by their creativity, thus, making sure that the assignment is complete. Finally, the existing e-Learning cannot replace vocational training instruments, however, it aims to complement the quality of learning [60].

Based on the results of observations at the beginning of the pandemic, all teachers were required to carry out Distance Learning (PJJ) [58] - [60], which is famous for its online system. This learning method made students to be able to learn independently by carrying out practical subjects in accordance with their respective creativity. It involved the teachers monitoring the practice through photo/video reports sent by the students. The Software Engineering (RPL) teacher prepared materials such as electronic components for the sred-light simulation. Meanwhile, another teacher asked students to study the practical material through videos. Therefore, the students could use instructional videos made by the teachers and other sources.

PJJ theory subjects make students active because they are asked to take notes, do assignments, and look for other supporting material. However, the students' perceptions differ in interpreting the material without direct explanation. Therefore, they are confused about following the learning flow during PJJ.

PJJ uses a lot of online learning applications such as google meet, google classroom, zoom, Edmodo, Microsoft teams, school web, and others. Meanwhile, online learning is divided into asynchronous and synchronous. Asynchronous is a learning session without the need to equalize time between students and teachers [61]. This session provides leeway for students to study and collect assignments up to a certain deadline. Meanwhile, synchronous is a learning session that involves equalizing the time between the teacher and students. This session often encounters problems such as system errors, bad internet networks, and unsupported devices.

Based on observations, teachers and students have not fully mastered online learning applications, therefore, learning was still less varied. Some teachers also do not make interesting PJJ media such as gamification. Meanwhile, based on the information, student attendance was not like face-to-face learning where the students that attend are only about ½ of the class during PJJ. Some students were actively discussing, and those that were aware of their duties and obligations got their 4C skills through PJJ. However, the reality in the field shows that PJJ is an inaccurate system for vocational high school students because it makes them have a lazy personality. The results also showed that some students felt that PJJ conditions were an opportunity to work in order to help the family economy.

*Teacher skills in HOTS-based teaching,* the skill of implementing learning was ascertained from the teacher questionnaire analysis that reviewed learning from the 4C skill dimensions [11], [13], [18], and [22]. The analysis showed that the teachers had good skills in implementing HOTS Lesson Plan-based learning. Table VIII below shows the descriptive analysis on the learning implementation questionnaire according to the perceptions of productive teachers, using the SPSS 25 software.

## TABLE VIII: Descriptive Statistics SPSS 25

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **N** | **Minimum** | **Maximum** | **Mean** | **Std. Deviation** |
| Learning Implementation | 115 | 2.24 | 4.00 | 3.1639 | 0.34534 |
| Critical Thinking Dimension | 115 | 2.25 | 4.00 | 3.1783 | 0.38010 |
| Collaboration Dimension | 115 | 2.00 | 4.00 | 3.1696 | 0.44862 |
| Creativity Dimension | 115 | 2.00 | 4.00 | 3.1687 | 0.39166 |
| Communication Dimension | 115 | 1.67 | 4.00 | 3.1391 | 0.41648 |
| Valid N (listwise) | 115 |  |  |  |  |

Table VIII is the result of statistical calculations using SPSS. The calculation includes the number, minimum value, maximum value, mean, and standard deviation. The table shows that the number of respondents was 115 teachers. Furthermore, in the learning implementation aspect, the minimum value was 2.24, while the maximum 4.00. The value interval showed that the respondents were in the category of rare, often, and very often in implementing HOTS-based learning.

The value intervals in the learning implementation aspects are composed of the 4C skill dimensions and the mean obtained determines the category of each dimension. The categories of each dimension are shown in the following table.

When the standard deviation is less than the mean value it indicates that the data obtained is less varied. Table IX shows the analysis results of the learning implementation questionnaire.

## TABLE IX: Analysis results of the learning implementation questionnaire

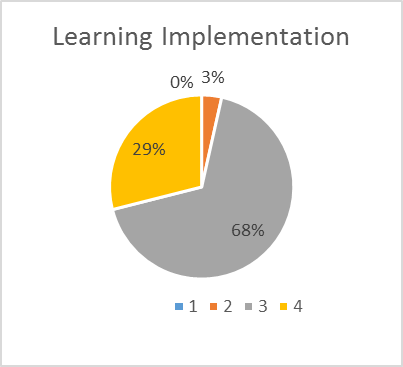
|  |  |  |  |
| --- | --- | --- | --- |
| **No** | **Criteria** | **Achievement level interval** | **Category** |
| 1 | Learning Implementation | 3.1639 | Good |
| 2 | Critical Thinking Dimension | 3.1783 | Good |
| 3 | Collaboration Dimension | 3.1696 | Good |
| 4 | Creativity Dimension | 3.1687 | Good |
| 5 | Communication Dimension | 3.1391 | Good |

The interval for the achievement level of HOTS-based learning implementation is the mean of the 4C skill dimensions. The analysis results showed the number 3.1639, which means that the teachers have good skills in implementing the learning process. The learning implementation questionnaire refers to several subjects as in table X below.

## TABLE X: Learning implementation questionnaire items

|  |  |  |
| --- | --- | --- |
| **Questionnaire items** | | **Analysis** |
| Dimension | Critical thinking | Delivery of HOTS-based materials and assignments |
| Collaboration | Discussion opportunity |
| Creativity | Creative thinking opportunity |
| Communication | Communication opportunity |

The following is a diagram showing the quantity of HOTS-based learning implementation.



1. Learning implementation diagram

The learning implementation diagram is a percentage description of the combined data results between Critical Thinking, Collaboration, Creativity, and Communication dimensions. The interpretation of the diagram is described in table XI.

## TABLE XI: Interpretation of the learning implementation diagram

|  |  |  |
| --- | --- | --- |
| **Score** | **Percentage** | **Interpretation** |
| 1 | 0% | The learning implementation was still based on LOTS, thus, students were not required to think critically |
| 2 | 3% | The learning carried out was based on HOTS, therefore, students began to learn to think critically |
| 3 | 29% | The HOTS basis in learning was often used by teachers, therefore, the students were getting used to carrying out 4C |
| 4 | 68% | HOTS-based learning was always implemented, therefore, the demands of carrying out 4C could be fulfilled by students without any problems |

## Teachers' skills in evaluating HOTS-based learning

Learning evaluation analysis was carried out on learning evaluation documents. The evaluation document is a series of instructional design documents that have been previously evaluated. The realm of analysis includes the questions used in the evaluation of written learning. The analysis refers to the KKO of the revised Bloom taxonomy [48] and [52]. Table XII shows the data analysis results of the learning documentation preparation.

Based on the table below, it could be seen that the learning evaluation is still dominant using KKO at levels C1 - C3 or LOTS. Based on the interview, the teachers had been trained on making HOTS-based questions, however, the practice of constructing HOTS-based instructional designs was still lacking. The assignment was only given independently without intense assistance. Furthermore, the training was not followed up with further activities or regulations that emphasized the use of HOTS. This caused teachers to return to conventional teaching practices.

## TABLE XII: Analysis of instructional design and learning evaluation.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Instructional design document** | | | | | **Written Evaluation Documents** | |
| **Learning** | **Competency** | | **Indicators of Competency Achievement** | |
| **Model** | **HOTS** | **LOTS** | **HOTS** | **LOTS** | **HOTS** | **LOTS** |
| Problem Based Learning, and Project Based Learning. | 0% | 100% | 5% | 95% | 45% | 55% |
| Problem Base Learning. | 67% | 33% | 17% | 83% | 26% | 74% |
| Discovery Learning, Project Based Learning, AMD Problem Based Learning | 21% | 79% | 22% | 78% | 36% | 64% |
| Inquiry Learning | 29% | 71% | 20% | 80% | 13% | 88% |
| Discovery Learning, Project Based Learning, and Problem Based Learning | 73% | 27% | 73% | 27% | 32% | 68% |
| Discovery Learning | 25% | 75% | 0% | 100% | 38% | 62% |
| Average of analysis document items | 36% | 64% | 23% | 77% | 32% | 68% |
| Average percentage of HOTS KKO | | | | | | 30% |
| Average percentage of LOTS KKO | | | | | | 70% |

# Discussion

Based on the research data on teacher knowledge, it was discovered that the skills of teachers in constructing instructional designs varied. However, they generally have good HOTS-based learning knowledge. The factual and conceptual dimensions show good categories, and even the procedural and metacognitive dimensions are included in the superior category. Meanwhile, the analysis of the instructional design document shows the gap between the method and the KKO used. The method in instructional design includes types of HOTS learning, while the KKO used was still LOTS. The teacher should construct an instructional design using C4-C6 level KKO, because levels C1-C3 are still being used.

Teachers' skills in HOTS-based teaching experience are still limited. Based on observations, some teachers had started modifying face-to-face learning with online learning that requires 4C skills before the pandemic. However, even after the pandemic the teachers and students have not fully mastered online learning applications. This was evidenced by the lack of variation, communication, and collaboration in learning. Teachers should have mastered online learning before its implementation, however, the pandemic situation urged learning to run even though it was not optimal.

Based on interviews, the students felt that learning during a pandemic did not integrate technology and information. According to [62], the ability to integrate technology into learning affects teacher performance in running the curriculum. This situation makes the application of HOTS in learning less effective.

Based on research data on HOTS, the teachers' ability to carry out HOTS-based teaching is good. This is because the aspects of critical thinking, collaboration, creativity, and communication have been fulfilled by then, and fall into the good category. However, in evaluating learning, the teachers still dominantly used questions with the LOTS level KKO. This shows that there was a mismatch between the design, implementation, and evaluation. There is a possibility that this is due to the teacher's lack of understanding (misconception) on the relationship between learning components.

The strengthening of HOTS-based learning patterns has been regulated in the 2013 curriculum [46], which includes aspects of design, implementation, and assessment. Based on the research data on the ability to construct instructional design, teachers still have difficulty linking design with learning activities. They have succeeded in writing KKO at the HOTS level, however, not in its implementation in activities. Therefore, teachers should use innovative learning models, such as inquiry-based learning, problem-based learning, case studies, and others. This kind of learning model is very adaptive for vocational education and needs to appear explicitly in the instructional design. Instructional design and teaching experiences carried out by teachers affect the effectiveness of the learning process, including student learning outcomes [63]. This is because the design is able to guide learning in order to make time and effort more effective and efficient [64].

The use of innovative learning models such as inquiry-based learning has a significant effect on students' critical thinking skills in science and technology [22] and [65]. Inquiry facilitates a form of productive engagement with inquiry-based science [66].

Problem-based learning is an ideal, evidence-based, and superior choice [13] to fill the skills gap in critical thinking. Furthermore, it is persistent and highlights the strengths of the Z Generation [35] and [67]. This learning process has a good learning effect [36].

Project-Based Learning teaches students to create projects that reflect knowledge [68]. Additionally, it is comprehensive to engage students in authentic problem investigation [69]. HOTS-based learning models could shape scientific, including social behavior, and develop a sense of curiosity [70].

The model is starting to fulfill the demands of the 21st-century with regards to learning implementation, which needs to sustain the implementation of 4C skills [71]. Students' 4C skills would be developed when the teacher uses HOTS-based learning. This is because the performance of teachers becomes higher by developing critical thinking skills [72]. These skills make a person more adaptable, flexible, and better able to deal with the rapid development of information [73]. Critical thinking skills in the aspects of interpretation, analysis, evaluation, conclusion, explanation, and self-regulation could be effectively improved through HOTS-based learning activities [21]. The use of innovative learning models is in accordance with the goals of vocational education. Moreover, this education system needs to develop effective problem-solving thinking abilities in students, hence they are ready to work [74].

Effective learning designs are able to facilitate student involvement in learning interactions [23], [75]. Meanwhile, the strengthening of HOTS-based learning patterns is regulated in the 2013 curriculum [46]. This strengthening involves developing the learning patterns that are centered on students in order to develop their special potential in plural science and critical learning [46]. The mindset emphasizes the implementation of HOTS in classroom learning.

HOTS development is an effort to improve the quality of learning and graduates [76]. Therefore, HOTS would be a support career in the future [13]. Vocational high school students' perceptions about the information on the world of work and specifically, student readiness for work are in a very good category [77].

Educating a workforce in science, technology, engineering, and mathematics (STEM) of high quality in the long term requires consideration of individual career development [78]. Therefore, practical experience has a high contribution to work readiness [79].

Based on observations of the learning implementation in vocational education, it was found that teachers and students could easily adapt to HOTS-based learning when in practical classes, however, they experience difficulties in theory classes. HOTS learning is mostly implemented when students practice, from problem analysis to problem-solving until product work for machines, buildings, and electrical/information engineering.

Based on the questionnaire analysis results, teachers have good skills in implementing HOTS in practical learning. Moreover, practical learning activities could improve students' 4C skills [13], [21], and [22]. This finding strengthens the public's prediction that vocational high school students prefer practical lessons to theory.

The learning evaluation analysis results showed that HOTS level KKO was still not used optimally. Effendi [47] stated that students would get used to solving problems that develop higher-order thinking skills when the teacher develops questions at levels C4-C6 [80]. The results also showed that even though teachers have been trained, they still have difficulty preparing HOTS-based learning evaluations. Therefore, the government needs to monitor the implementation of HOTS-based learning regularly and continuously.

This discussion concluded that the implementation of HOTS learning in Vocational High Schools was not optimal. This could be seen from the gaps in every aspect of learning, from design to evaluation.

Learning document problems may occur due to the large and varied burden of teachers. Therefore, based on the data, it is necessary to evaluate the workload and performance of teachers. The evaluation results could form the basis for future learning policies.

# Conclusion

This research concluded that HOTS-based learning in vocational high schools needs special attention. Furthermore, teachers and students are able to develop this mode of learning in practical classes, however, not in theory classes. Regardless, though it has been developed in practical classes, the strengthening of the knowledge dimension about HOTS learning still needs to be improved.

For the theory class, the teacher experienced difficulty implementing HOTS-based learning. This was indicated by gaps in the preparation of instructional design, implementation, and evaluation. Additionally, in these three aspects, teachers were still confused between HOTS and LOTS.

This research answers the question on the reason students have not mastered HOTS to its full potential. It also recommended that education providers carry out training and make regulations that emphasize HOTS-based learning.

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