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Reconstruction of Chemistry Curriculum Elements of Vocational School (SMK) of Mechanical Engineering Study Program

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A B S T R A C T

To support the productive subject of expertise field, chemistry curriculum elements and materials in SMK need to be reconstructed. This study aims to produce an integrated chemistry syllabus of Mechanical Engineering in SMK. This study uses a development research method with research subjects: 2 chemistry education experts, 6 chemistry teachers, 4 productive teachers and 2 vice curriculum principals at SMKN Bandung. The results show the relevant chemistry KD to the Mechanical Engineering KD includes knowledge and skill competencies: explaining, describing, applying, determining, identifying, classifying, analyzing, constructing, proposing ideas, designing and conducting experiments. The compositions of chemical content that is relevant are types, physical and chemical properties, symbols, roles, handling of hazardous chemicals, and standard chemical safety and security in the work environment (5.9%), redox reactions (11, 8%), electrochemistry (11.8%), thermochemistry (11.8%), physical and chemical properties of metals, pure metals and alloys (11.8%), electron configurations and the periodic system (5.9%), bonding chemical (5.9%), corrosion (5.9%), metallurgy (5.9%), hydrocarbons (5.9%), petroleum (5.9%), polymers (5.9%), and reaction rate affecting factors (5.9%). The learning strategy is a scientific approach of discovery learning, project-based learning, problem-based learning, and guided inquiry. The evaluation results are the competence of knowledge, skills and attitudes assessment.

1. Introduction

Chemistry is a subject that is not only taught in high school (SMA) but also in vocational high schools (SMK). In SMK, it is given to the students to implement scientific methods through experiments and to have basic chemistry skills as a foundation for developing competence in each area of expertise (Widodo, 2017).

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Chemistry subjects are a group of basic vocational subjects aim to be a support and foundation for expertise program subjects so it is important for vocational students to master the basic concepts in chemistry (Wiyarsi, Hendayana, Firman, & Anwar, 2015; Yuliastini, Rahayu, Fajaroh, & Mansour, 2018). Chemistry is also one of the basic subjects for studying engineering (Sönmez, 2014).

The main challenge for the vocational level is the ability to meet the changing skills of individuals and the work field. This is in accordance with the principle of lifelong learning (Hrmo, Miština, & Krištofiaková, 2016). Based on the facts, students at the vocational level with low scores in chemistry think that chemistry subjects are not relevant to their vocational fields (Boddey & Berg, 2015). The problems also occur in 2013 curriculum of Indonesia. Several research also show some problems such as the delivery of material sometimes does not match the planned syllabus, a lot of material addition but the time is limited, errors in the curriculum content, and students in SMK assume that chemistry subjects are not important or useful because they are not relevant to their vocational fields and the lack of links between chemistry and everyday life (Haryanti & Wiyarsi, 2017; Kastawi, Widodo, & Mulyaningrum, 2017; Murwindra, Yuhelman, & Musdansi, 2017; Arungpadang, Longdong, & Patras, 2018; Lia & Isnaeni, 2018). The change in a curriculum is also only focuses on changing the document, rather than the implementation, evaluation or assessment of learning (Jatmoko, 2013).

Another problem seen is that there are almost no differences between the material taught in SMK and SMA, which impacts learning motivation of students at the SMK level (Hartanto & Fordiana, 2018). Based on the results of a pre-research conducted by Aeni (2019) in an SMK, 84% of students did not like chemistry lessons, due to a lack of interest in these subjects. In other words, the irrelevance of chemistry subjects with vocational interests for students can result in low interest, motivation and achievement of chemistry students. To increase student interest in learning in SMK, more meaningful selection of chemical materials according to the needs of students at the SMK level is needed (Haryanti & Wiyarsi, 2017). To obtain chemistry material that is relevant to SMK level, having relevance between the materials and various elements in the chemistry curriculum and the vocational curriculum is important. This is in accordance with the function of the curriculum as a method used to achieve educational goals (Fauzan, 2017).

Based on the description, the adaptive chemistry material in SMK does not support productive subjects in the field of expertise. Thus, elements of the chemistry curriculum, especially in Mechanical Engineering, need to be reconstructed including basic competencies, content, strategies and learning evaluation. The research aims is to produce an alternative syllabus that integrates elements of the chemistry curriculum with the vocational elements in the Mechanical Engineering study program.

2. Methodology

The method used is Development Research (DR) with the stages of design, development, and evaluation. The subjects in this study were based on the purposive sampling technique (Sugiyono, 2015) with a composition consisting of 2 chemistry education experts, 6 SMK chemistry teachers, 4 productive teachers, and 2 Deputy Head of Curriculum (Wakakur) / at SMK Mechanical Engineering expertise study program. This research was conducted at SMKN 2 Bandung and SMKN 6 Bandung. The research object consists of educational standards in the Mechanical Engineering for SMK, chemical teaching materials for Mechanical Engineering for SMK, teaching materials for the basic subject group of the Skills Program (C2) of Mechanical Engineering for SMK, Chemistry subject syllabus, and C2 Mechanical Engineering syllabus for subjects. The research instrument uses a basic competency (KD) validation format, content, knowledge and design dimensions and evaluation of chemistry learning. The research data was analyzed qualitatively with the stages of data reduction, data presentation and drawing conclusions.

3. Results and Discussion

Basic Chemistry Competencies that are Relevant to the Demands for Basic Competencies of SMK Mechanical Engineering Study Program

The data obtained in this section is the basic competence (KD) of chemistry that is relevant to the demands of KD in the basic subject group of the skill program (C2) in the SMK Mechanical Engineering expertise study program, which includes the subjects of Basic Mechanical Engineering Work (PDTM) and subjects Basic Mechanical Engineering Design (DPTM) contained in the attachment to the Regulation of the Director General of Primary and Secondary Education of the Ministry of Education and Culture Number: 07/D.D5/KK/2018 (Kemendikbud, 2018).

Based on the Regulation of the Director General of Primary and Secondary Education of the Ministry of Education and Culture Number 464/D.D5/KR/2018, the KD of the SMK subjects in the Mechanical Engineering study program group C2 is divided into 3 subjects with details in table 1 below (Kemendikbud, 2018).

Table 1. KD of basic subject of expertise program (C2) SMK mechanical Engineering expertise study

No	Subjects	Total of Basic Competence
1.	Mechanical Engineering Drawing	9
2.	Basic Mechanical Engineering Work (PDTM)	10
3.	Basic Mechanical Engineering Design (DPTM)	18
Total		**37**

Based on table 1, there are three subjects from the C2 group in the Mechanical Engineering study program for the competence of machine engineering skills,

welding techniques, metal casting techniques, industrial mechanics engineering and design techniques and Mechanical Drawings. Students must achieve the total of 37 KD. The following are the research findings of KD chemistry that are relevant to the demands of SMK Mechanical Engineering KD (table 2).

Tabel 2. Chemistry KD that is relevant to the demands of SMK Mechanical Engineering KD expertise study program

Code	Developed Chemistry KD
Che 1	• Describing hazardous chemicals types and properties and their role in mechanical engineering expertise (D) • Identifying hazardous chemicals type and properties and handling based on the chemical hazard symbol (D) • Implementing standard procedures on chemical safety and security in the work environment (D)
Che 2	• Applying the concept of oxidation and reduction reactions in welding (RD) • Analyzing metal-processing process (RD) • Applying the concept of oxidation and reduction reactions in iron ore processing reactions (RD)
Che 3	• Explaining the chemical process of metal welding electrically (RD)
Che 4	• Constructing an energy diagram of an exothermic reaction in oxy acetylene welding with endothermic reaction (RD) • Analyzing the heat of combustion of acetylene used in metal welding compared to other fuels (D) • Determining the H of the reaction based on Hess's law (RD) • Determining the heat reaction from the metal heat treatment process (RD) • Designing and conducting experiments to determine the heat of combustion of various fuels (RD)
Che 5	• Identifying the physical properties and chemical properties of metal (RD) • Identifying some physical and chemical properties of ferrous and non-ferrous metals in engineering materials (RD) • Classifying engineering materials according to their type (RD) • Explaining engineering materials in the form of pure metals and their alloys (RD)
Che 6	• Explaining engineering materials in the form of pure metals and their alloys (RD)
Che 7	• Analyzing the relationship between the electron configurations of elements with

Code	Developed Chemistry KD
	their location in the periodic table (RD)
Che 8	• Analyzing the factors that influence the occurrence of corrosion and how to overcome them (D) • Proposing ideas to prevent and overcome corrosion of metals (D)
Che 9	• Explaining the processing of metals from the earth's crust (metallurgy)
Che 10	• Analyzing the structure and properties of solid, liquid, and gaseous fuels with their impact on the environment and health and how to overcome them (RD)
Che 11	• Explaining the principle of petroleum processing (RD) • Identifying the technical process for separating petroleum fractions (RD)
Che 12	• Analyzing the structure, properties and uses of synthetic and natural polymers (RD) • Identifying synthetic and natural polymers used as engineering materials (RD)
Che 13	• Analyzing the factors that affect the reaction rate in metal heat treatment (D)

Description:
RD : Redesigned ; D: Designed
Based on the table, the relevant KD of chemistry to Mechanical Engineering SMK KD includes knowledge and skill competencies: explaining, describing, applying, determining, identifying, classifying, analyzing, constructing, proposing ideas, designing and conducting experiments.

Table 3 shows the percentage data on the relevance of chemistry KD with vocational Mechanical Engineering in the C2 subject group.

Table 3. Percentage of chemistry KD required by SMK Mechanical Engineering KD

Subjects (C2)	Total of KD	Total of Chemistry KD Relevant to SMK KD	Percentage (%)
GTM	9	0	0
PDTM	10	2	5,4
DPTM	18	5	13,5
Total	**37**	**7**	**18,9**

Description: GTM: Mechanical Engineering Drawing; PDTM: Mechanical Engineering Basic Work; DPTM: Basic Mechanical Engineering Design

Based on the table, the C2 subject group for Mechanical Engineering expertise requires 18.9% KD chemistry support. Therefore, chemical KD and chemical

content are in accordance with the needs of productive subjects to support the needs of Mechanical Engineering Vocational Schools.

Meanwhile, based on the validation results, the validator agrees that chemical KD is integrated with KD Mechanical Engineering Vocational School that has been developed. However, several validators were not relevant to some of the chemical basics that were developed along with suggestions. In addition, some validators only provide advice but still agree to the chemical KD integrated with the vocational KD. Suggestions given by the validator are in table 4.

Table 4. Suggestion of Developed Chemistry KD Formula

Designed/Redesigned Chemistry KD		**Suggestions**	
		Suggestions from SMK Chemistry Teacher	**Suggestions from SMK Teacher**
CHE 1	• Describing the types and properties of hazardous chemicals and their roles in mechanical engineering expertise (D)	• K4 Teacher: For the SMK level, the minimum is C3, meanwhile describing belongs to C2. Thus, it should be replaced by determining, it includes C3. • K5 Teacher: Replace describing in C2 with determining, which is C3. • K6 Teacher: In SMK, the minimum is C3, describing is C2, and replace with determining	-
CHE 5	• Identifying characteristics of physics and metal chemistry (RD)	-	• Waka Kur 2: Analyzing (C5) while identifying (C3). RD should not be derived from the existing KD
CHE 2	• Applying the concept of oxidation and reduction reaction in welding (RD)	-	• Waka Kur 2: Explain the concept of carburizing and neutral flame as well as the oxidation.
CHE 3	• Explaining the chemical process of metal welding electrically (RD)	• K4 Teacher: The word explaining is C2, while minimal must be C3, replace it with applying. • K5 Teacher: Since explaining is C2 (SMK minimum C3), replace it with applying • K6 Teacher:	-

Designed/Redesigned Chemistry KD		Suggestions	
		Suggestions from SMK Chemistry Teacher	**Suggestions from SMK Teacher**
		Replace explaining with applying as it is C2, and the minimum for SMK is C3.	
CHE 4	• Constructing energy diagram of an exothermic reaction in oxy acetylene welding with an endothermic reaction (RD)	• K4 Teacher: The construction is already C4 but maybe simpler and still the indicator can be measured again with the word make, which is also C4.	-
CHE 4	• Analyzing the heat of acetylene combustion used in metal welding compared to other fuels (D)	-	• Waka Kur.2: Must add KD 4
CHE 5	• Explaining engineering materials pure metals and the alloys (RD)	• K4 Teacher: Replace explaining still C2 with identifying or looking for anything else above C2. • K5 Teacher: Replace describing is with identifying. • K6 Teacher: At the SMK level, minimum C3, replace explaining still C2 with identifying	-
CHE 6	• Analyzing the relationship between electron configuration element and the position in periodic table (RD)	-	• Waka Kur. 2: Must add KD 4
CHE 7	• Analyzing the forming process of chemical bonds in several compounds used in mechanical engineering (RD)	-	• Waka Kur.2: Ensure the material discussed in KD 3.1 and KD 4.1 in the DPTM subject to be harmonized with the chemistry subject.
CHE 8	• Proposing an idea to avoid and overcome metals corrosion (D)	• K4 Teacher: Replace proposing an idea with overcoming (C6)	-
CHE 9	• Explaining the processing principles of earth's crust (metallurgy) (D)	• K4 Teacher: Explaining still belongs to C2, replace it with analyzing. • K5 Teacher: The word explaining is C2, thus replace it with	• Must add KD 4

Designed/Redesigned Chemistry KD		Suggestions	
		Suggestions from SMK Chemistry Teacher	**Suggestions from SMK Teacher**
		analyzing. • K6 Teacher: Replace explaining with analyzing, as it is C2.	
CHE 10	• Analyzing the structure and properties of solid, liquid and gaseous fuels with their impact on the environment and health and how to solve them (RD)	-	• Must add KD 4
CHE 11	• Explaining petroleum processing principle (RD)	• K4 Teacher: Explaining is still C2, thus replace it with analyzing. • K5 Teacher: Since explaining is C2, replace it with analyzing • K6 Teacher: Change explaining into analyzing	• Checked on subject materials syllabus 3.3 and 4.3 in DPTM
CHE 11	• Identifying the separation process of petroleum fractions (RD)	-	• Checked on subject materials syllabus 3.3 dan 4.3 in DPTM
CHE 13	• Analyzing the factors that affect the reaction rate in metal heat treatment (D)	-	• Must add KD 4.
CHE 3	• Explaining the chemical process of metal welding electrically (RD)	• K4 Teacher: Replace explaining with applying • K5 Teacher: Replace explaining with applying • K6 Teacher: Replace explaining with applying	• PDTM 2 Teacher: The material on information related to vocational KD described is not studied in DPTM. The electrical material studied in the DPTM subject is only the basic, such as calculating current, voltage resistance, power, Kirchof's law, and making electrical circuit. Thus, this vocational KD is not related to the KD in column (4). Chemical KD in column (4) is better listed only in PDTM subject of welding KD. • DPTM 2 Teacher: In the DPTM subject

Designed/Redesigned Chemistry KD	Suggestions	
	Suggestions from SMK Chemistry Teacher	**Suggestions from SMK Teacher**
		for KD 3.8 understanding the basics of electricity and KD 4.8 practicing the basics of electricity, there is no welding process. Materi yang dibahas adalah The material discussed is about the concept of electricity, the law of electricity and variety of electrical circuits. • Waka Kur.2: Recheck the material of DPTM subject in syllabus.

The suggestions given can improve the product to obtain an integrated chemistry KD design with vocational.

Chemical Content that is Relevant to the Demands of the Mechanical Engineering Study Program

The data includes chemical content that is relevant to the vocational content required by the Mechanical Engineering Vocational School. The chemical content formulated is based on the chemical KD developed through information related to the vocational KD (vocational content) in the Mechanical Engineering SMK book. Table 5 shows the percentage of chemical content that is relevant to vocational content.

Table 5. Percentage of chemical content relevant to vocational content

Code	Chemical Content in Chemical Context of Mechanical Engineering Vocational School	Vocational KD Code	Total of Chemical Content relevant to Vocational Content	Percentage (%)
CHE 1	Types, physical properties, chemical properties, symbols, roles, and handling of hazardous chemicals, as well as standard procedures for chemical safety and security in the work environment.	PDTM 1	1	5,9
CHE 2	Redox reactions (redox reactions in welding and iron ore processing)	• PDTM 8 • DPTM 2	2	11,8
CHE 3	Electrochemistry	• PDTM 8	2	11,8

Code	Chemical Content in Chemical Context of Mechanical Engineering Vocational School	Vocational KD Code	Total of Chemical Content relevant to Vocational Content	Percentage (%)
	(electrochemistry in metal welding)	• DPTM 8		
CHE 4	Thermochemistry (exothermic and endothermic reactions in oxy-acetylene welding; reaction enthalpy; Hess's law; heat of reaction in metal heat treatment; heat of combustion of acetylene and other fuels used in mechanical engineering)	• PDTM 8 • DPTM 4	2	11,8
CHE 5	Physical and chemical properties of metals, pure metals and metal alloys in engineering materials	• PDTM 8 • DPTM 1	2	11,8
CHE 6	Electron configuration and the periodic system of the elements of engineering materials.	DPTM 1	1	5,9
CHE 7	Chemical bonds (chemical bonds in compounds used in mechanical engineering)	DPTM 1	1	5,9
CHE 8	Corrosion (Corrosion of metallic materials)	DPTM 1	1	5,9
CHE 9	Metallurgy (Processing metals from the earth's crust)	DPTM 2	1	5,9
CHE 10	Hydrocarbon (Physical properties, chemical properties, and impacts of solid, liquid, and gas fuels and their countermeasures)	DPTM 3	1	5,9
CHE 11	Petroleum (Petroleum processing principle)	DPTM 3	1	5,9
CHE 12	Polymer (Structure, Physical properties, Chemical properties, and use of polymer in engineering materials)	DPTM 3	1	5,9
CHE 13	Factors affecting the reaction rate in metal heat treatment.	DPTM 4	1	5,9
	TOTAL		**17**	**100**

Note: PDTM 1: Basic Mechanical Engineering Work KD 3.1 and 4.1; PDTM 8: Basic Mechanical Engineering Work KD 3.8 and 4.8; DPTM 1: Basic Mechanical Engineering Design KD 3.1 and 4.1; DPTM 2: Basic Mechanical Engineering Design KD 3.2 and KD 4.2; DPTM 3: Basic Mechanical Engineering Design KD 3.3 and 4.3; DPTM 4: Basic Mechanical Engineering Design KD 3.4 and 4.4; DPTM 8: Basic Mechanical Engineering Design 3.8 and 4.8; Calculating $Percentage\ (\%) = \frac{Total\ Chemical\ Content\ relevants\ to\ Vocational}{17} \times 100\%$

Figure 1 shows the composition of chemical content by Mechanical Engineering SMK in the C2 subject group.

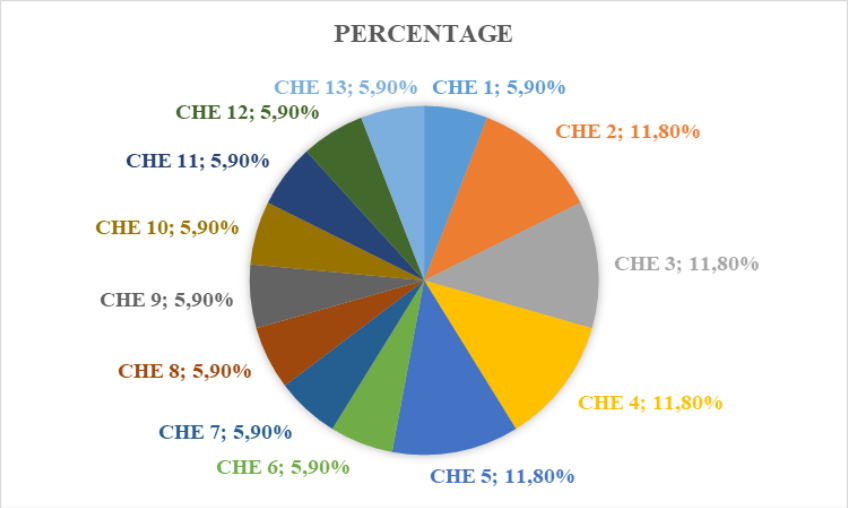

Figure 1. Diagram of Chemical Content Composition Relevant to the Needs of Vocational Schools of Mechanical Engineering Expertise Program

Based on table 5 and figure 1, the largest percentage of chemical content required by Mechanical Engineering SMK in the C2 subject group is redox reactions; electrochemistry; thermochemistry; physical properties and chemical properties of metals, pure metals and metal alloys in engineering materials as supports. While the smallest percentage is on type content, physical and chemical properties, symbols, roles, and handling of hazardous chemicals, as well as standard procedures for chemical safety and security in the work environment; electron configurations and the periodic system of elements; chemical bonds; corrosion; metallurgy; hydrocarbons, petroleum; polymer; and the factors that affect the reaction rate.

According to the validation results of the integrated chemical content formulation of Mechanical Engineering Vocational School, almost all validators agree on the relevance of chemical content to vocational content. However, 2 validators do not agree on the relevance of 1 chemical content towards vocational content. The validators give suggestions in table 6.

Table 6. Suggestions on the developed chemical content

Vocational KD	Developed Chemical Content	Suggestions	
		Suggestions from SMK Chemistry Teacher	Suggestions from SMK Teacher
• Applying the welding process • Performing routine welding process	• Concept of oxidation and reduction reaction • Application of oxidation and reduction reactions to welding reactions	-	• Waka Kur. 2: Complete with carburizing and neutral
• Understanding electrical Basics • Practicing the electrical basics	• Electrochemistry • Application of electrochemistry on metal welding	-	• PDTM 2 Teacher: The electrical material studied in the DPTM subject

Vocational KD	Developed Chemical Content	Suggestions	
		Suggestions from SMK Chemistry Teacher	**Suggestions from SMK Teacher**
			such as calculating current, voltage, resistance, power, Kirchof's law, and making electrical circuits is basics. Thus, this vocational content is not related to KD and chemistry content. KD and the developed chemical content are better listed only in KD and welding content of PDTM subject. • DPTM 2 Teacher: Welding was not learned in the KD

Suggestions given on the content of redox and electrochemical reactions in metal welding used as product improvements to obtain content that is integrated with Mechanical Engineering Vocational School.

Dimensions of Factual, Conceptual, Procedural and Metacognitive Knowledge on Chemical Content Relevant to the Needs of Vocational Schools of Mechanical Engineering Expertise Program

The data are factual, conceptual, procedural, and metacognitive dimensions of vocational integrated chemistry content. The formulation of this knowledge dimension is based on Anderson and Krathwohl's Taxonomy (Anderson & Krathwohl, 2017).

The dimensions of factual knowledge in this study formulated based on facts related to chemical content at Mechanical Engineering Vocational Schools. Meanwhile, conceptual knowledge is in the form of essential concepts related to the integrated chemical content of Mechanical Engineering Vocational School. The formulation of the procedural dimension is a series of steps to be followed regarding the application of chemistry at the Mechanical Engineering Vocational School. Metacognitive knowledge in the form of knowledge of awareness and cognition of students in their efforts to improve memory skills and understanding of chemical content related to Mechanical Engineering skills.

Based on the results, all validators agree on the overall formulation of the knowledge dimension. It shows good relevance of knowledge dimension and in accordance with the demands and needs of the Mechanical Engineering Vocational School.

Learning Design and Evaluation of Chemistry Learning at SMK Mechanical Engineering Expertise Program

This design is focused on knowledge, skills, and attitudes; learning resources and places of learning; learning experience; learning strategies; and evaluation of learning. The first part consists of knowledge, skills and attitudes. The knowledge section contains chemical concepts that students must possess or achieve in vocational integrated chemistry content. The skills section contains developed skills and practices for students in vocational integrated chemistry content. Meanwhile, the attitude section contains the students' attitudes in achieving vocational integrated chemistry content learning.

The second part is the source and place of learning. It contains books, website addresses, and places of the teaching and learning process of chemistry learning that is adapted to the integrated chemistry content of the Mechanical Engineering Vocational School.

The third is a learning experience that contains the activities of students in gaining knowledge. While the fourth is a learning strategy that contains approaches and models of chemistry learning with its syntax according to the integrated vocational chemistry content consisting of a scientific approach and various learning models including discovery learning, project-based learning, problem-based learning, and guided inquiry. A scientific approach used as it is an important characteristic in the development of the 2013 curriculum (Setiadi, 2016). The characteristics of discovery learning are in the discovery itself by providing opportunities for students to be able to find and build their own knowledge (Miatun, 2018). While the advantages of project-based learning increase student learning outcomes, students not only developing cognitive abilities, and achieving connections with real problems (Efstratia, 2014). Janson et al. (2015) stated that the purpose of PBL learning is to improve students' generic learning skills such as collaboration, synthesis, communication and problem solving. Meanwhile, Inquiry based learning is a system that can develop students' problem solving and critical thinking skills (Maxwell, Lambeth, & Cox, 2015).

The last part is a learning evaluation includes an assessment of students' knowledge, skills and attitudes to the integrated chemistry content of Mechanical Engineering Vocational School. The knowledge competency assessment consists of a written test and assignments. Skills assessment consists of performance in the lab, performance appraisal, project appraisal and product appraisal. Meanwhile, attitude assessment consists of attitude observation and peer assessment.

According to the results, all validators agreed to the overall design formulation and evaluation of chemistry learning that could be used as a reference in chemistry learning in SMK. It proves that the learning design and evaluation in chemistry learning in Mechanical Engineering Vocational School that has been formulated has good relevance to the vocational integrated chemistry content with some validators' suggestions. However, 2 validators still provide suggestions related to learning resources, places to study and evaluation of learning. One

validator suggested that the proposed learning resource is a learning resource used as reference material for both chemistry teachers and productive teachers at Mechanical Engineering Vocational Schools. In addition, optimizing the learning place in the classroom by using various media is also suggested. Another validator, suggesting that places of study can be added with DUDI. It means that students can learn directly in the business and industrial world. Another suggested adding an assessment with a portfolio, especially in the evaluation of learning. Portfolio is an assessment of the collection of process and work sample documents providing information students' abilities development within a certain period of time (Firman, 2018). Suggestions given can be used to improve the product of good relevance between the formulated chemistry learning design and vocational integrated chemistry content.

4. Conclusion

Based on the results of data analysis and discussion, KD of chemistry relevant to the KD of SMK Mechanical Engineering study program includes knowledge and skills: explaining, describing, applying, determining, identifying, classifying, analyzing, constructing, proposing ideas, designing and conducting experiments. Meanwhile, the chemical content that is relevant to the demands of the SMK Mechanical Engineering study program consists of types, physical properties, chemical properties, symbols, roles, and the repetition of hazardous chemicals, and standard procedures for chemical safety and security in the work environment; redox reactions; electrochemistry; thermochemistry; physical and chemical properties of metals, pure metals and metal alloys; electron configurations and the periodic system of elements; chemical bonds; corrosion; metallurgy; hydrocarbons; crude oil; polymer; and the factors that affect the rate of the reaction. The knowledge dimension is based on chemical knowledge related to Mechanical Engineering Vocational School. The learning strategy is a scientific approach with various learning models: discovery learning, project-based learning, problem-based learning, and guided inquiry. Meanwhile, the learning evaluation contains an assessment of the competence of knowledge, skills and attitudes. The knowledge competency assessment consists of a written test and assignments. Skills assessment consists of performance in the lab, performance appraisal, project appraisal and product appraisal. In addition, the attitude assessment consists of attitude observation and peer assessment.

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