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TEACHING MATERIALS FOR CHEMISTRY OF HYDROCARBON AND PETROLEUM BASED VEHICLE CONTEXT FOR VOCATIONAL SCHOOL STUDENT ON AUTOMOTIVE ENGENEERING

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ABSTRACT

This study analyzed characteristic, advisability and response students about the chemistry teaching materials of hydrocarbon and petroleum based vehicle context for vocational school student on automotive engineering. Exploratory mixed method have been conducted in this research method. The procedures were using four step, there are qualitative, development, quantitative, and interpretation. The instrument were open questionnaire to obtain input data and close questionnaire to assessment products. Chemistry teaching materials of hydrocarbon and petroleum based vehicle context for vocational school student on automotive engineering was product in this research. The product was made by integrating chemistry materials and automotive materials base competence. Chemistry teaching material was interated by vehicle context in first desciption, activities, examples, and exercies. Based on data analysis, teaching materials were proper with some critical from content aspect by expert judgement. The advisability about teaching materials by teachers included in very good category and response of teaching materials by students included in very good category. Based on that result teaching materials as a source of learning for students and as a source learning for teacher to support the success of learning chemistry on program automotive engineering.

Keyword: teaching materials, based vehicle context, automotive engineering, exploratory mixed method, chemistry of hydrocarbon and petroleum

1. INTRODUCTION (10 PT)

The aim of vocational school is preparing the students to work in certain sector, so it principles will be diffirent with senior high school although twice from junior high school (UU RI, 2013). Vocational school is emphasize at practices than theory, but it was conducted by vocation subject only, wasn't be the other subject learning. Thus, the students wasn't

interest of some subject matter. Chemistry is ones of subject matter which the students wasn't interest, because they are feeling that it difficulty lies in the number of formulas and terms that must be memorized (Wiyarsi, Pratomo, & Priyambodo, 2017). Actually, chemistry is basic material in the vocational curriculum to support vocatioanal materials, prepare basic student ability in expand expertise and good chemistry litracy implementation (Sevian & Bulte, 2015; Wiyarsi, 2017). It is not appropriate with the vocational student, they likes practice to find the concept than memorized only. However, practice method in chemistry lesson can not applyed to vocational schools because time allocation in curriculum wasnt being enaugh and many of matter must be learned.

Vocational teaching and learning was fundamentally different from any other type of teaching and learning except in one respect that of context. The context is integrating basic competence vocation when proces, objective, and outcome would be wished in learning (Faraday, Overton, & Cooper, 2011). Thus, context-based learning is one approach to chemistry learning that can be used to attract interest in vocational school students. Context-based learning will increase knowledge to connect chemistry learning to the community, it will be attracting students interest to chemistry learning, because contain applications required by students (Blondera, Zemlera, & Rosenfelda, 2016). Faraday, Overton & Cooper (2011) are adding context to vocational school is a broader concept to form the analysis and students' critical thinking on science. However, context-based learning has not been widely practiced in vocational school because teachers was being difficult to conecting application in a particular skill program. Thus, teachers needed reference to apply context-based learning in chemistry learning to optimize knowledge about applied chemistry and student skills.

Chemical teaching materials with automotive engineering contexts would be needed because teaching materials are relevances of everyday life, competance, learning objectives, and literacy saince can make it easier for students to master chemistry (Ikävalko & Aksela, 2015; Kapici & Funda, 2015; Bybee & McCrae, 2011). Development of teaching materials that have been done Abualrob & Daniel (2013) with stages, first prepare the draft of teaching materials, then consult the truth of the draft of teaching materials to the material experts. After that, analyze the curriculum that will become the reference of developing material in teaching materials. Next, identify the development objectives and compile the components in the teaching materials, then do the validation of teaching materials to curriculum experts, materials and science teachers.

In the study of Vaino et al. (2012) sequence of context-based teaching materials begins by presenting the desired context of learning, then presenting problems to be solved and solving science issues by combining some scientific knowledge. Ikävalko and Aksela (2015) added that teaching materials also showcase phenomena related to the contexts of everyday life. Context-based teaching materials also contain contact phases, questioning or cultivating curiosity, elaboration, exploring and connecting (Vos, Taconisa, Jochemsa, & Pilotb, 2011).

In addition, content in context-based teaching materials includes experimental activities, inquiry activities, scientific perspectives and chemical history (Chen & Wei, 2015). Albualrob and Daniel (2013) add a component of teaching materials covering science, technology, and social elements such as context, content, scientific processes or skills and attitudes. Thus, context-based teaching materials have a good quality if the teaching

materials contain material that presents the problem according to the context that can be solved with inquiry activities and scientific perspectives and fosters curiosity and develops student skills. Chemical teaching materials that fit the context will attract students of automotive engineering because the chemistry studied directly can be applied in the field studied automotive engineering. Thus, students will be enthusiastic in following the chemistry learning in the classroom.

Automotive engineering is one of the skills program in vocational school which attracted by students. As many as 219 vocatioanal schools in Yogyakarta there are 97 schools that organize automotive engineering program (Dispsmk, 2017). However, the study of chemistry in the automotive engineering program is general that chemical applications for automotive engineering are lacking. It is consistent with research from Wiyarsi et al. (2017) that the learning of chemistry in automotive engineering progam has not conected with the material on automotive technique so that the chemistry matter is difficult to understand and student is not interested in chemistry learning.

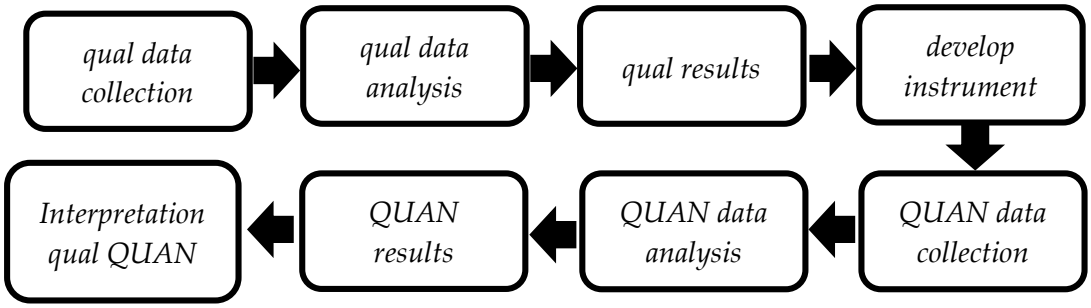
Subject of automotive engineering student learning is what is in the vehicle. Vehicle is a unity of complex systems so that the need for an understanding from various points of view of science such as chemistry. However, students' interest in learning only on subjects of skill courses is taken less interest in other sciences. Applications of chemistry that can be applied in vehicles quite a lot, such as fuel oil (BBM), fuel content is none other than chemical compounds and many types of fuel used for vehicles so that students are able to distinguish the types of good fuel and master the ins and outs of all types of fuel used on vehicles. Therefore, students need an appropriate learning resource to understand what is in the vehicle not only on material in automotive engineering but rather from other scientific point of view such as chemistry and able to increase student interest in chemistry learning.

In relation to the development of chemical teaching materials, previous research has been conducted on feasibility testing of LKS oriented approach to contextual material of chemical rate with the result that context-based chemical material is feasible to be used because it can improve students' critical thinking skill (Arifin & Nasrudin, 2014). Based on these results, it can be obtained information that the development of chemistry with a contextual approach is enough to give positive results for learning. Thus, a chemistry teaching material with a vehicle context for current Automotive Engineering students is indispensable.

Therefore, the research development is expected to help meet the needs of teaching materials in accordance with the context of vocational Automotive engineering and the fulfillment of the need for chemical materials vocational school is also expected to improve the quality of chemistry learning in vocational school

2. RESEARCH METHOD (10 PT)

The development research have been using exploratory mixed method. The aims of research method was explorating problem and developing product with design research show in picture 1. (Creswell & Clark, 2012).



Gambar 7. Design Research Chart

Based on Figure 1, it can be explained that product development systematic begins with qualitative data collection. Qualitative data had obtained from the exploration results related to the problem under study. Furthermore, the data is analyzed, resulting in qualitative data as a whole. The results of qualitative data analysis are used as the basis for the preparation of products. Furthermore, instrument development is conducted to assess the feasibility of product development, so that quantitative data is obtained. Quantitative data are analyzed, resulting in final quantitative data. The data is then converted according to the ideal conversion guidelines, to obtain the feasibility category.

The qualtative steps

Firstly, the exploratory problem was collected with interview teachers of chemistry in vocational school about chemistry learning in vocational school on automotive engineering. The interview was including five aspect, there are: (a) curriculum chemistry in vocational school, (b) source learn, (c) vocation contect integration, (d) chemistry learning in vocational school and (e) learning problem to be quality learning. Descritive analyze had used from the result of interview. After that, analyze basic competence in vocational school curriculum 2013 and basic competence of chemistry in vocational school on automotive engineering progam with analyze sheet. The analyze sheet is table was conecting chemistry basic competence, basic competence on automotive engineering can integerated with chemistry learning and chemistry content in automotive engineering context. The result of analyze qualitative was arranging of teaching material will develop.

Instrument Development

The pinciples of instrument development were adopted on development research from (Abualrob & Daniel, 2013) with steps as following preparation, arranging and validation of teaching material. The step of preparation, firstly is determine book source will reference to arrange teaching material, there are chemistry and automotive engineering books. After that, determine content skeleton with considering of consistent and content aspects as well as determining context on automotive engineering will use the teacing material of chemistry.

The teaching material will arrange with making layout, arranging content of chemistry, and development content. After that, validation steps to jugment of chemistry learning as content validation. Feasibility test from chemistry teachers and legibiliy test from automotive engineering students, the twice is media validations. The validations steps was used open questionaires with specific declaration for each chapther. Its aim to knowing in a proper manner and judements of content propers. The content validation questionare was containing 31 items in four components, there are vocational content integration,

content proper, precentation, and grammer. Then, the media validators had been used to review layout and reading aspect from teacher and student. The feasibility and legibility test was containing negative statment to reduce wrong teaching material layout. The qualitatif data would be used to consider revision of product.

The quantitative steps

The quantitative steps have purposed to proper assessement from reviewer and student responses about product. The reviewer is five chemistry teachers in vocational school on automotive engineering. It have spesification minimum had been teaching 10th year and bechelor chemistry education degree. The student subject is ten students in vocational school on automotive engineering had been learning chemistery subject in this product. The closed questionaare had been used in this steps. The assessment quastionare had arranged with instru ment adaptation assessment teaching material from Education National Standart Institution (BSNP) and development teaching material based context journal from Abualrob dan Daniel (2013), Ikävalko dan Aksela (2015), Chen dan Wei (2015), Vaino et al. (2012), dan Vos et al. (2011). The adaptations were resulted 29 item indicator from five component, there are content proper, layout, grammer, vocational content integration and reading aspect. Then, the response quationare had arranged adaptation from reading literacy in Programme for International Student Assesment (PISA) (2006). The adaptations were resulted 18 item statment rensponse student about product. The reviewer and responses student was resulted qualitatitif data. It had been conterted become quantitative data with Likert scale, thus optained average scors each component.

3. RESULTS AND ANALYSIS

3.1 The initial product development results

The initial product development results are obtained in the qualitative and development stages. The qualitative stage consists of several steps, namely qualitative data collection, qualitative data analysis, and qualitative data results. The results of qualitative data will be used as a reference for conducting drafting stage of chemistry materials.

- Qualitative Data Collection

Qualitative data collection was conducted to collect information about problems in student learning in automotive engineering program. The researcher undertook needs analysis with the initial interview of the chemistry teacher. Based on the results of the interview can be seen that there are some problems in learning chemistry for automotive engineering program, namely:

a. Teachers have difficulty in relating chemical learning content to be studied with the context of a student's skill program because chemistry teachers in vocational schools are less good at automotive engineering subjects and not just teaching one skill program.
b. The absence of a special chemistry book for the Automotive Engineering Expertise Program, all programs still use the same chemistry book.
c. Learning resources used are self-made modules with reference derived from several high school books and the internet.
d. Students are less motivated in chemistry learning because they assume chemistry is not related to the student's vocational context.

e. Students find it difficult to study chemicals because they consider many calculating chemistry.

- Qualitative Data Analysis

Based on the qualitative data obtained, it is found that the vocational students are less motivated in following the chemistry lesson, this is because the chemistry learning in vocational school is still given in general because the teacher has difficulty to relate the chemistry learning with the student's skill program. Yet not all the materials in chemistry can be used to support their vocation. On the other hand, this is the underlying researcher in developing context-based chemistry materials.

Chemical materials that can be integrated with automotive vocational contexts are hydrocarbon and petroleum chemistry, this is due to many automotive fields that use hydrocarbon compounds and petroleum processing products such as for fuel oil and vehicle lubricants. The next process is to determine the main target of teaching materials users, ie students and teachers. Another advantage of this resource is that it can be used publicly, because the material presented still covers everyday life.

After determining the main objectives, then analyzed the core competence and basic competence of chemistry subject in vocational school containing hydrocarbon and petroleum chemicals and basic competence subjects of automotive engineering program. This analysis aims to find out basic competece in automotive engineering vocational subjects that can be integrated with basic competence chemical petroleum material.

- Qualitative Data Result

Based on the analysis of qualitative data that has been done, the results obtained in the form of matrix of chemical content with automotive engineering vocational context developed from the results of research Wiyarsi, Patana, and Sulistyo (2017) in Table 1.

Table 1. Chemical Content Integration Matrix with Context of Automotive Engineering

Chemical Basic Competencies	Contentable Chemistry Content Related	Content Vocational Lessons Chemistry	Content Integrated Chemistry Content Vocational Engineering Automotive
3.9 Analyze the structure, properties of hydrocarbon compounds and the combustion effects of hydrocarbon compounds	- Naming of hydrocarbon compounds - Reaction of hydrocarbon compounds - Application of reaction of hydrocarbon compounds in everyday life - The impact of burning hydrocarbon compounds on	• Energy conversion process on the machine • Process performance of heat exchanger / radiator • How to treat diesel fuel systems • Emissions content in flue gases	- Introduction of carbon and hydrocarbon compounds Grouping of hydrocarbon compounds - Naming of hydrocarbon compounds - Physical properties of hydrocarbon compounds - Isomers of hydrocarbon compounds

Chemical Basic Competencies	Contentable Chemistry Content Related	Content Vocational Lessons Chemistry	Content Integrated Chemistry Content Vocational Engineering Automotive
	the environment and health and prevention.		- Reaction of hydrocarbon compounds - Impact of combustion of hydrocarbon compounds - The concept of heat energy
3.10 Scanning techniques for separation of petroleum fractions and their uses	- Separation techniques of petroleum fractions - The types of petroleum fraction based on the boiling point - Usage of petroleum fraction for daily life	• How to care steering system and steering panel • Conventional gasoline fuel system / carburetor and gasoline engine injection system and diesel engine • Vehicle lubrication system	- Material change - Types of mixed separators - The formation of petroleum - Processing of petroleum - Fuel - Solar - Lubricant - Usage of petroleum products in daily life

- Drafting of Instructional Materials

At this stage the initial product produced in the form of hydrocarbon and petroleum chemistry materials for students vocational automotive engineering based on the context of the vehicle consisting of 112 pages with several components. This component of the teaching material is determined by reference analysis, discussion, and on the matrix of chemical content of the vocational context. Components of teaching materials are:

a. Hydrocarbon and Petroleum Compounds on Vehicles

This section is an introduction to teaching materials in general which contains descriptions of hydrocarbon and petroleum chemicals present in vehicles. Each material description begins with a vehicle-related image or scheme to stimulate initial knowledge and attract students to learn more about the subject.

b. Matrix of Chemical Content Integration with Context of Vocational Automotive Engineering

This section is a table that contains basic chemistry competencies in vocational school, chemistry contexts that can be taught, vocational content of automotive engineering related to chemistry learning, and chemistry content integrated vocational content Automotive

Engineering which is the result of integration of chemistry basic competence with vocational automotive engineering basic competence.

c. Concept Map Integrated Automotive Engineering

Contains a description of hydrocarbon and petroleum chemistry linkages with automotive engineering as the basis of the order of presentation of content in teaching materials.

d. Fill Instructional Materials

This section contains hydrocarbon and petroleum chemicals based on vehicle context or vocational on automotive engineering. Chemical material in this teaching material is arranged in accordance with the level of student needs of vocatioanal school on automotive engineering which is accompanied by examples in the automotive world and is equipped with chemical info, practicum activities, and exercise questions. This hydrocarbon and petroleum chemistry teaching material consists of 3 chapters each chapter consisting of 12 components.

e. Reference

This section contains a list of references used by the author as a basis for preparing hydrocarbon and petroleum chemistry resources.

f. Glossary

This section contains an explanation of all the important terms contained in the teaching materials.

g. Index

This section contains important words and pages in teaching materials to help students search for the word in the resource.

h. Elements Periodic Table

Contains the latest periodic system of elements used internationally.

- Validatioan result

The product of hydrocarbon and petroleum chemistry teaching materials for vocational automotive based on vehicle context which have been compiled and consulted to supervisor lecturer, then validated by 2 lecturers for review of chemistry learning expert, 3 chemistry teacher of VOCATIONAL SCHOOL Teknik Otomotif for feasibility and student review Automotive Engineering for legibility review as a user. The input data of the three reviews is used as a consideration for revision. The following are the entries obtained from each of the review of chemistry learning expert, feasibility, and readability.

a. Content Validation Result

The following inputs are obtained from content validation by chemistry learning experts.

1) There are still many words that are typo or typo, there is less sentence writing and punctuation in accordance with the correct General Regulation of Spelling Indonesian (PUEBI) in the teaching materials.
2) The use of sentences in some introductory chapters is still less clear and less precise.
3) Images and captions in the teaching materials are still unclear.

4) The logo or brand on the cover and the lubricant products in Chapter 3 is better omitted.
5) The writing of a phase on the chemical reaction equation is skewed.
6) Some material concepts are not quite right.
7) Questions on page 51 need clarity.
8) Each sub-section is bold because it's still not clear even though the colors are different.

b. The Media Validation Result

Validation looks done with feasibility and readability reviews. The input data obtained from the feasibility review involves the improvement of the structure of kaliamt, punctuation, numbering, and some chemical concepts that are still less precise. then for the results of legibility test by the students include the replacement of the typeface, the size of the letter is too small and illustrated images clarified.

All entries from content validation by chemistry learning experts and media validation are accepted for revision of instructional materials.

3.2. Reviewer response data

Products that have passed the revision of the validation stage, then elaborated the feasibility of teaching materials to 5 chemistry teachers in vocational school as a reviewer and tested students' responses to the developed teaching materials. Reviewer conducts a review of the feasibility of the teaching materials using the assessment questionnaire that has been prepared.

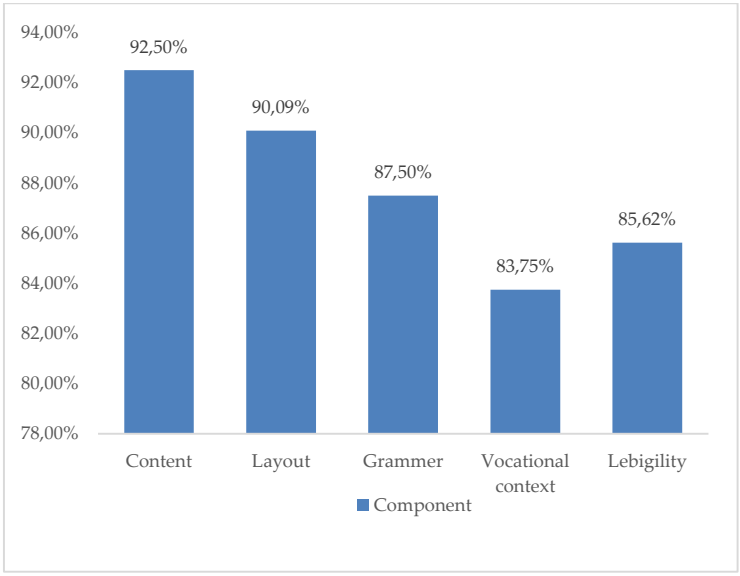
The result data of the assessment of the feasibility of the teaching materials are qualitative and input. Here are the inputs obtained from reviewers.

a. There is still a lack of proper word writing on teaching materials
b. The correct octane pertamax turbo number is 95
c. Each start is better given the page so readers are easier to search.
d. Material of the concept of heat energy already exists on the material thermochemistry so that no need to be included again only the students need diingakan course.
e. Mixed separation material is not usually included in the material of hydrocarbon and petroleum compounds but in the solution material.
f. The display of the repaired material restored the layout.

The reviewers critical are not used as a consideration of the revision of teaching materials and the reasons. The material of the concept of thermal energy already exists on the thermochemical material so that it is not necessary to be included again only the students need to diingakan course, this is not revised because in the curriculum 2013 revised edition 2017 of the directorate general of primary and secondary education thermochemical material is not in basic competence, so put on this material is due to the combustion of the hydroxycon compound to produce heat which is directly connected with the heat conversion on the radiator by the addition of the thermochemical material. Mixed separation material is not normally included in hydrocarbon and petroleum chemicals but on the solution material. Chemical separation materials are incorporated in hydrocarbon and petroleum chemicals as the basis of the petroleum separation process and other solvent separation processes as enrichment or reference materials for students. The input data from the accepted reviewer is used as the basis for revision in improving the quality of the developed teaching material.

The feasibility assessment was resulted of the teaching materials in the form of qualitative value will then be converted into quantitative value at the interpretation stage

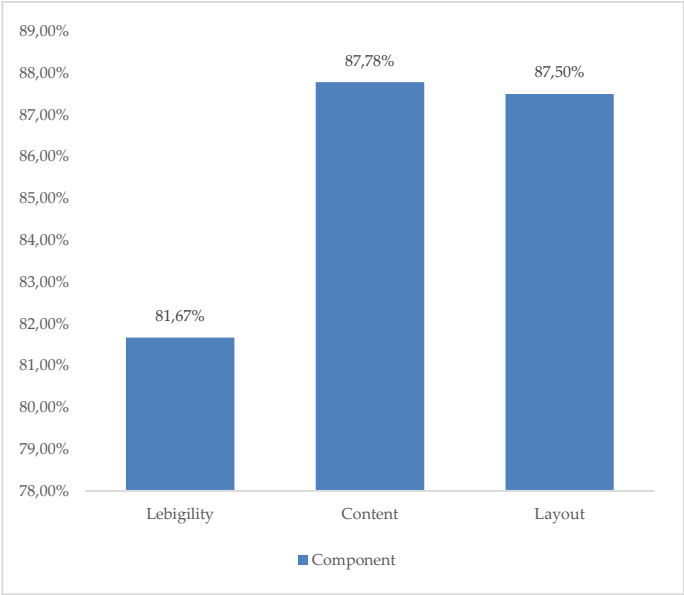
by using Likert scale. The data is then analyzed, so that the average score of each component and converted into qualitative criteria according to the category of component assessment. Based on the analysis, the assessment of the feasibility of teaching materials by the reviewer obtained the average score of the overall component of the teaching materials of 102.8 from a maximum score of 116. Based on the ideal scoring criteria in Appendix 13, the average score of 102.8 entered in the range $\bar{X} \geq 96.6$ with the category of Excellent Feasibility (SB). The overall percentage value of the product as a whole is 89.04%. According Widoyoko (2012), teaching materials are said to be used if the percentage of the assessment results have reached criteria score of at least 51% -75%. Thus hydrocarbon and petroleum-based petroleum-based chemical materials are suitable for use as a source of chemistry learning. The feasibility assessment had been resulted for the pecentage of ideality can be seen in Picture 2 as follows.



Picture 2. Graph of Quantitative Result

Based on the graph, the integration component of the vocational context has the lowest percentage of ideality compared to other eligible components and has a good category. Such integration may be due to the lack of interest in chemistry learning in vocational schools, as students assume that the chemicals taught are not related to the learned vocabulary (Wiyarsi et al., 2017). In other words, teachers do not provide chemicals that integrate automotive engineering so that it is difficult to understand the material of automotive engineering related to chemicals.

Then, the student response was resulted overall average score of 61.7 from a maximum score of 72. The average score is included in the range $\bar{X} > 61.2$, so it has the category of Excellent Feasibility (SB) with the percentage of idealization 85,69%. Thus, it can be concluded that students' responses to hydrocarbon and petroleum-based petroleum-based materials for Vocational Automotive Engineering are excellent. The diagram showing of feasibility categories of each component in Figure 3 is shown.



Picture 3. The graph of Result students response

4. CONCLUSION (10 PT)

Based on the analysis and discussion, the conclusions was obtained that chemistry teaching material of hydrocarbon and petroleum based vehicle context for vocational school on automotive engineering which has been successfully developed has characteristic, that is based on the result of integration of chemical content with automotive engineering subject content derived from chemical basic competence analysis of vocational school and basic competence of automotive engineering subjects with integration of automotive-based vehicle context techniques contained in the early narrative section of the chapter, activities, examples and questions. The chemical teaching material product is eligible with some inputs based on chemistry learning experts and the feasibility based on the reviewer (teacher) as the user is included in the excellent category (SB). Students' responses about product is also provide excellent response (SB).

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