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Chemistry in context: The development of hydrocarbon chemistry and petroleum module based on vehicle case

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Abstract. This study aims to analyze the characteristic, feasibility, teachers' and students' responses of Hydrocarbon Chemistry and Petroleum (HCP) module based on the context of vehicle case on automotive engineering. Exploratory mixed method has been employed in this research. The research procedures used four steps including qualitative, development, quantitative, and interpretation step. The instruments used to collect the data consisting the three questionnaires, one open questionnaire to obtain the validation and two close questionnaires to collect the teachers and students' responses toward the HCP module. HCP module based on the context of vehicle case on automotive engineering program was yielded as a result of this reseach. The characteristic of research product was integrating between chemistry and automotive subject based on basic competence of curriculum and integrated by vehicle context in first chapter, concept map, activities, examples, and exercise. A group of experts consisting two lectures were confirmed that the HCP module has a correct chemistry content. A very good category was given as the response of the teacher. Moreover, the students response were very interest toward the HCP module. The students and the tachers could be utilize the HCP module as learning sources reference to gain a succesfull chemistry learning.

1. Introduction

Vocational school is emphasizing at practices than theory, but it was conducted by vocation subject only, was not be the other subject learning. The students weren't interest of some subject matter, for example in chemistry. Chemistry is ones of subject matter that the students were not interest, because they feel that it difficulty lies in the number of formulas and terms that must be memorized [1]. Actually, chemistry is basic subjects in the vocational curriculum to support vocational subjects, prepare basic student ability in expand expertise and good chemistry literacy implementation [1-2]. Vocational student likes practice to find the concept than memorized only. However, practice method in chemistry lesson not yet applied to vocational schools because the limited time allocation in the school.

Vocational learning was fundamentally different from any other type of learning except in one aspect, namely context. The context is integrating basic competence vocation when process, objective, and outcome would be wished in learning [3]. Context-based learning is one approach to chemistry learning that can be used to increase student's interest in learning chemistry. Context-based learning will increase knowledge to connect chemistry learning to the community, because contain applications required by students [4]. According to [3] vocational school context 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 a teacher was being difficult to connecting application in a particular skill program [1]. Thus, teachers needed reference to apply context-based learning in chemistry learning to optimize knowledge about applied chemistry and student skills.

Chemistry based contexts module would be needed because chemistry module is relevance's of everyday life [5], competence, learning objectives [6], and literacy sciences [7], it easier for students to master chemistry. In the study of [9], the sequence of context-based chemistry module was presenting the desired context of learning in the beginner of each chapter, then presenting problems to be solved and solving science issues by combining some scientific knowledge. Context-based chemistry module also contains contact phases, questioning or cultivating curiosity, elaboration, exploring and connecting [10]. Content in context-based chemistry module includes experimental activities, inquiry activities, scientific perspectives and chemical history [11]. Accoding to [8] that explain a component of chemistry module covering science, technology, and social elements such as context, content, scientific processes or skills and attitudes. Thus, context-based chemistry module has a good quality if the chemistry module contains material that presents the problem according to the context that can be solved with inquiry activities and scientific perspectives, fosters curiosity, and develops student skills.

Automotive engineering is one of the program in vocational school, which the chemistry learning is general that chemistry applications for automotive engineering are lacking. It confirmed the previous study conducted by [1] that the learning of chemistry in automotive engineering program has not connected with the material on automotive technique so that the chemistry matter is difficult to understand and student is not interested in chemistry learning. Chemistry based context module is need to developed in automotive engineering program. It will increase the students' interest because the content of chemistry was correlate to the automotive engineering conten. Thus, students will be enthusiastic in following the chemistry learning in the classroom.

Vehicle context is principle subject in the automotive engineering learning. Vehicle is a unity of complex systems, so it needs for an understanding from various points of knowledge view, such as chemistry. Applications of chemistry that can be applied in vehicles quite a lot, such as fuel oil and lubricating oils [1], fuel oils have contained chemical compounds, the many types of fuel oils had used for vehicles, and it needs students knowing. 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 chemistry module, previous research has been conducted on feasibility testing of work sheets oriented approach to contextual material of chemical rate with the result that context-based chemistry module is feasible to be used because it can improve students' critical thinking skill [12]. The development of chemistry with a context-based is enough to give positive results for learning. Thus, chemistry module with a vehicle context for current automotive engineering students is indispensable. Therefore, the research development is expected to help meet the needs of chemistry module 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.

The following research question guide this study. How are the characteristic, feasibility, teachers' and students' responses about the HCP module based on vehicle case for vocational school student on automotive engineering program?

2. Method
Exploratory mixed method design was employed in this research. The aims of this research method were the exploration of the problem and developing the product. The scheme of this research design according to [13] showed in figure 1.
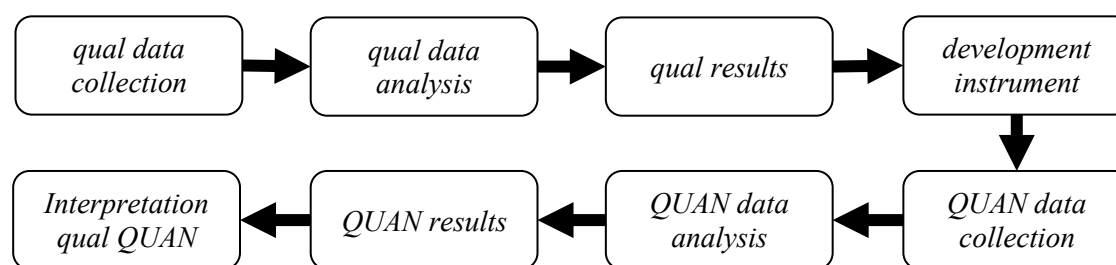
Figure 1. Design Research Chart

Based on figure 1, it can be explained that product development systematic begins with qualitative data collection. Firstly, the exploratory problem was collected by interview with the teachers of chemistry in vocational school. The topic of the interview was about chemistry learning in vocational school on automotive engineering program. In addition, the basic competence in vocational school curriculum and basic competence of chemistry in vocational school on automotive engineering program were analyzed through the sheet analysis. The sheet analysis is a table connecting the basic competence on chemistry and automotive engineering, which can be integrated on chemistry learning. Hence, the chemistry content could be integrated according to the automotive engineering context. The result of the qualitative analysis showed that arranging teaching material on chemistry topic based on the context of automotive engineering program was necessary.

The principles of instrument development were adopted from [8] with the steps consisting the preparation, arranging and validation of teaching material. The step of preparation, firstly is determine the source of the books that used as a reference on arranging the teaching material to arrange teaching material, there are chemistry and automotive engineering books. After that, determine content framework with considering of consistent and content aspects as well as determining context on automotive engineering will use the teaching material of chemistry. The chemistry module have arranged by making layout, arranging content of chemistry, and development content. Finally, a validation step was conducted by asking the judgment from chemistry education experts toward HCP module. They were review about some component to judgment feasible or not the product. Aims to collect the responses from the user in the term of the assessment from teacher and student responses about product. The teacher responses was knowing the product to using in learning chemistry and student responses was knowing to interest them about the product. The results of these steps were the average scores on each component of assessment. Finally, the interpretation of qual-quan step was score conversion based on ideal conversion from [15].

2.1. Research subject

The research subject consisted two expert judgments by validation, five teachers and ten students by user responses on automotive engineering program. The expert judgments were the lecture of chemistry education department and teaching the hydrocarbon and petroleum subject. All teachers were having teaching experiences more than 10 years and minimum graduate of bachelor degree. The teachers ware The students in automotive engineering program enrolled on hydrocarbon chemistry and petroleum course. The students came from the school which belongs to the same district of Yogyakarta.

2.2. Instrument

The interview guidelines had been used to teachers' interview. It was including five aspects, there are: (a) curriculum chemistry in vocational school, (b) learning sources, (c) vocational context integration, and (d) Integration of chemistry subject with vocational context. The validations step was used an open questionnaire with specific declaration for each chapter. For example: *Is chemistry content had been adjusted in automotive engineering?*. Its aim to knowing in a proper manner and judgments of content

correctness. The content validation questionnaire was consisting of 31 items in four components; there are vocational content integration, content proper, presentation, and Indonesian grammar rules.

The closed questionnaire have used in this quantitative steps. The teacher response questionnaire had arranged with the adaptation of assessment module from Education National Standard Institution (BSNP) and the development module based context journal from [5, 8, 9, 10, 11]. The adaptations were resulted 29 items indicator from five aspects; there are content, presentation, leanguage, integration of vocational context and readability. Then, the student's response questionnaire had arranged adaptation from reading literacy in Programme for International Student Assessment (PISA) [14]. The adaptations were resulted 18 items statement response student about product. The teacher and student responses were resulted qualitative data. It had been converted become quantitative data with ideal conversion, thus obtained average scores each component.

3. Results and Discussion

3.1 Qualitative Data
Qualitative data was collecting information about problems in student learning in automotive engineering program to knowing needs analysis from interview of the chemistry teacher. The results of the interview showed that some problems in learning chemistry for automotive engineering program, due to the result focused on the topic only.

Firsly, the curriculum chemistry in vocational school. The teachers' opinion about curriculum chemistry in vocational school had been appropriated with student necessary, but each chapter have not relating with subject in vocational program and it has limited time in practice plan allocation besides many matter which must to learned. Student centers' learning is demand of curriculum to teaching chemistry in the class. The teacher was difficultly, because students are less motivation and interest about chemistry. Second, learning sources. It was using self-made modules with reference derived from several high school books and internet, because special chemistry book for the automotive engineering program was not available. The impact given by students was study chemistry subject is general, not specific.Third, the Integration of chemistry subject with vocational context. It had been used to open lesson but not all of chemistry subject can be integrated. The teachers have difficulty in relating chemistry content with the context of a student's program, because chemistry teachers in vocational schools are less good at automotive engineering subjects and not just teaching one program. Finally, chemistry learning in vocational school. Students are less motivated in chemistry learning, because chemistry was not related to vocational subject. However, the effort of teacher had been related each chemistry subject in opening lesson and example chemistry in vocational subject if it's be present. In addition, they have difficult to study chemistry, because consider many calculating in chemistry. Hydrocarbon chemistry and petroleum subject had taught with paper task, a glance, and not practice in laboratory. Due to the teacher reasons which category of chemistry subject which memories only, nothing calculating.

According to interview result, it is founding that the vocational students has less motivated in the chemistry lesson, because the teachers has difficulty to relating chemistry learning with the student's program so chemistry learning in vocational school is general. The case is underlying researcher in development HCP module based on vehicle case.

3.2 Development Instrument
The product of HCP module based on vehicle case was resulted in development instrument. Firstly, it was analyzed core and basic competences of chemistry subject in vocational school with basic competence subjects of automotive engineering program. The analysis aims are find out basic competence in automotive engineering vocational subjects that can be integrated with basic competence chemical subject. The result is integrated matrixes of chemical content with automotive engineering vocational context, for example was shown in table 1.

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

Basic Competence of Chemistry	Content able Chemistry Content Related	Content Vocational Lessons Chemistry	Integrated Chemistry Content to Vocational Engineering Automotive
3.9 Analyze structure, properties and combustion impact of hydrocarbon compound	- Type of hydrocarbon compound - Naming of hydrocarbon compound - Reaction and life application of hydrocarbon compound - Combustion impact of hydrocarbon compound for surrounding and healthy	• Energy conversion process at machine • Work process of heat exchanger/ radiator • Treatment of diesel fuel system • Emission contents in throw gas.	- Introduction of carbon and hydrocarbon compound - Grouping and naming of hydrocarbon compound - Physic properties of hydrocarbon compound - Isomerization of hydrocarbon compound - Reaction of hydrocarbon compound - Combustion impact of hydrocarbon compound - Heat energy concept

　　The HCP module was arranging base integrated matrix. The draft of materials had been produced consist of 149 pages with several components. The component is determined by reference analysis, discussion, and integrated matrixes. The product had been showed in figure 2.

Figure 2. The Product of Hydrocarbon Chemistry and Petroleum Module Based on Vehicle Case

The HCP module based on vehicle case have eight components, there are introduction books, matrix integration, concept map integrated automotive engineering, content modules, reference, glossary, index, and elements periodic table. The HCP module characteristic was integrating between chemistry and automotive subject based on basic competence of curriculum and integrated by vehicle case in first chapter, concept map, activities, examples, and exercise. First chapter is general introduction, which contains descriptions of hydrocarbon chemistry and petroleum present in vehicles. It begins with a vehicle-related image or scheme to stimulate initial knowledge and attract students to learn more about the subject. For example, ...*The combustion process was occured because fuels of motorcycle has liquid phase changed to gases phase. Actually, what is the fuel containing?If you not know them, Let's learn later in 3rd chapter about petroleum fraction*. The concept map is sketch of hydrocarbon chemistry and petroleum linkages with automotive engineering. It is the order basic of content presentation in module. Activities were containing discussion or practicum chemistry had connected to automotive engineering

subject. The matter of hydrocarbon chemistry and petroleum had completed with example chemistry in vehicle and the objectives of the exercise construct in HOTS.

The product has been compiled and consulted to supervisor lecturer, then validated by a group of experts consisting two lectures for review of chemistry learning experts. A group of experts was comment is there are still many words that are typo, less sentence writing and punctuation in accordance with the correct General Regulation of Spelling Indonesian (PUEBI) in the HCP module. The statement was showing in some introductory chapters is still less clear, images and captions are still unclear. The logo or brand on the cover and the lubricant products in chapter trird is better omitted. The writing of a phase on the chemical reaction equation is skewed. Some material concepts are not quite right. Each sub-section is bold because it's still not clear even though the colors are different. The sentence structures, punctuation, numbering, and some chemical concepts are still less precise. The comments from the group of experts was used to revison of HCP module, but it has been proper.

3.3 Quantitative data

Products have been revised of the validation stage, then assessment teacher and student responses to HCP module. The teacher's responses were using closed-questionnaire, which contains five aspects, and free critical. The teacher responses were resulted form of qualitative value will then be converted into quantitative value at the interpretation stage by using Likert scale. Then analyzed data and the result is average score of each aspect and converted into qualitative criteria according to the category of aspect assessment, it had showed in table 2.

Table 2. The teachers response result

Aspect	Teacher					Total	Average	Maximum Score	Response Category	Ideals (%)
	A	B	C	D	E					
Content	15	16	15	12	16	74	14.8	16	Very Good	92.5
Presentation	42	44	34	37	43	200	40	44	Very Good	90.9
Language	22	24	18	18	23	105	21	24	Very Good	87.5
Integration of vocational context	13	13	13	12	16	67	13.4	16	Good	83.8
Readability	15	14	12	13	14	68	13.6	16	Very Good	85.6
Total	**107**	**111**	**92**	**92**	**112**	**514**	**102.8**	**116**	**Very Good**	**88,6**

The teacher response had been obtained of average score on overall component is 102.8. Based on the ideal scoring criteria, it entered in the range $X \geq 93.75$ with the category of very good. The result was indicating that HCP module can have used to support of learning chemistry and student interest will increase.

3.3.1 Content aspect. According to the result, accuracy content indicator has lowest value response compared to the other indicator in content aspect. All people was representing to each chemistry subject to certain level. The research from [6] suggested that students have difficult to represent every material of science, so the teacher is expected to be able to represent chemistry subject into certain levels. Therefore, the accuracy aspect has lowest value, it possible for the teacher to represent truth of content according to their perception; even though according to the expert who is more mastering the accuracy content judges that, it is feasible.

Some teachers were adding suggestion about HCP module. Firstly, each start is better given the page so readers are easier to searching them. Then, the concept of heat energy had been already existing on thermochemistry so cannot be included again, the students need wished course only. Mixed separation subject is not usually included in the hydrocarbon compounds and petroleum, but in the solution. Display of the repaired content restored the layout.

The teachers critical are not used as a consideration of the revision, because that the concept of thermal energy already exists on the thermochemistry so that it is not necessary to be included again. The students need to wished course only, this is not revised because in the new curriculum,

thermochemistry is not in basic competence, so put on this material is due to the combustion of the hydrocarbon compound to produce heat. It is directly connected with the heat conversion on radiator by addition of thermochemistry. Then, mixed separation is not normally included in hydrocarbon and petroleum chemicals, but on the solution matter. Chemical separation is incorporated in hydrocarbon and petroleum chemicals as basis of the petroleum separation process and other solvent separation processes as enrichment or reference for students.

The other indicators on content aspect have the same value so that in terms of completeness, breadth and depth content, this HCP module has been very good category. Module had been complemented by student involvement activities, practicum activities and questions about the development of scientific literacy that relate directly to the context of student life. Therefore, this module is expected to increase students' motivation and interest in learning chemistry [10-11].

3.3.2 Presentation aspect. The presentation aspect has the most indicators than other aspect. It had been concluded that very good, because HCP module was presenting of overall indicator aspect in each chapter. However, student involvement activities and development of HOTS question indicators have the lowest value response. HOTS question is stimulating students' ability to apply their knowledge and solve problems related to everyday life, so that the development of HOTS requires the latest context in real life problems [16]. Thus, the development of HOTS questions in the context of automotive engineering were needed in order to master automotive engineering subject and produce good HOTS questions.

3.3.3 Language aspect. HCP module was using grammar instruction from General Regulation of Spelling Indonesian (PUEBI). The teacher response was finding some wrong sentence structure; it was causing to lowest value in accuracy sentence structure indicators. The overall of language aspect have very good category response.

3.3.4 Integration of vocational context aspect. The integration of vocational context aspect has lowest value compared to other aspects. This integration had caused that learning of chemistry in vocational schools is less interest to students, because the chemistry subject taught by teacher is not related to the vocational learning [1]. In other words, the teacher does not understand to integrated chemistry subject of automotive engineering, so that in assessing of HCP module cannot provide a maximum assessment of HCP module.

3.3.5 Readability aspect. According to the result, layout and font indicators have lowest value in this aspect. It was caused that some table and picture in HCP module was wrong arranging on some page. The teacher also was critical that some page layout have very full and less space between sentences, so the reader was not comfortable to read this module. The critical will used to improving the HCP module quality and overall the readability have very good category.

The students' response had been conducted assessment after teacher response. It was using closed-questionnaire, which contains 18 item of interest statements about HCP module. The interest statement in closed-questionnaire contains from three aspects, there are readability, content, presentation. The process analyze is same between teachers' response. The result had showed in table 3.

According to the table 3, readability indicators has lowest value in this aspect. It was caused when review the HCP module, the student conditions were not interest to chemistry. They have opinion that chemistry is difficult. The overall student response has included of very interest category. Thus, it can be concluded that students' responses to HCP module based on vehicle case are excellent.

Table 3. The student response result

Aspect	Students										Average score	Maximum Score	Category	Ideals (%)
	1	2	3	4	5	6	7	8	9	10				
Readability	22	23	24	18	19	24	17	14	18	17	19,6	24	Interest	81.7
Content	36	35	36	27	28	36	29	34	25	30	31,6	36	Very Interest	87.8
Presentation	12	12	12	9	8	12	10	9	9	12	10,5	12	Very Interest	87.5
Total	**70**	**70**	**72**	**54**	**55**	**72**	**56**	**57**	**52**	**59**	**61,7**	**72**	**Very Interest**	**85.7**

4. Conclusion

This research had been successfully developed of HCP module Based on the context of vehicle case on automotive engineering program. The characteristic of research product is integrating between chemistry and automotive subject based on basic competence of curriculum and integrated by vehicle context in first chapter, concept map, activities, examples, and exercise. HCP module had a correct of content aspect according to the expert judgments. The teacher response included in very good category and student response included in very interest category toward HCP module. The HCP module based on vehicle case could be used as learning sources for students and to support a successful chemistry learning on automotive engineering program

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