



## The Development of The Chemical Teaching Material Integrated to Nautical Material to Improve Understanding The Hydrocarbon and Petroleum Concept in The Shipping Vocational High School

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### Abstract

This research is development research aimed at producing chemically integrated teaching materials for commercial nautical vessels. The nautical vocational material for commercial vessels. namely ship machinery on the subject of the types of fuels and lubricants. is integrated into the subject matter of hydrocarbons and petroleum. In the subject matter of hydrocarbons and petroleum. vocational awareness of the environment and pollution prevention are also integrated. The study began with 4 stages. the phase define starts with identifying the needs of teaching materials in vocational voyage. at the stage design is made of teaching materials by integrating the two material vocational nautical commercial ships. stages develop are used to enhance the results of the phase design to validate and test of materials teach Validation used at this stage includes expert validation. readability and assessment. and trials to determine the response of students. The results of the study show that integrated chemistry teaching materials are very suitable to be used in chemical learning at the Vocational High School of Nautical. Based on the results of the analysis obtained a validity value of 3.72 (93%) with a very good category. for 94% of students showed a positive response to integrated chemistry teaching materials. The data obtained from the concept of understanding obtained  $t_{count} = 19.59 > t_{0.05, 32} = 1.699$  in learning using integrated chemistry teaching materials showing an increase in understanding of concepts. The final stage of this research is the stage disseminate by publishing through journals and implementing teaching materials in schools.

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## INTRODUCTION

Vocational education is an integral part of the education system in various countries. Vocational education is a strategic program to provide middle-level workforce (Winangun, 2017). UU/constitution number 20 of 2003 concerning the National Education System is defined as education that prepares students to be able to work in certain fields. The Minister of Education and Culture's Decree stated that the objectives of the Vocational High School education are such as: prepare students to continue to a higher level of education; improve the ability of students as a member of the community in conducting reciprocal relations with the social, cultural, and environment around; improve the ability of students to develop themselves in line with the development of science, technology, and art; prepare students to enter the work field with a professional attitude.

Yu (2013) states that the level of professionalism and low quality of education caused the quality of vocational education do not fulfill the need of the labor market yet. The result of observation toward graduated students of vocational school show that most vocational graduates have not been able to fulfill the needs of the labor market and have not been able to implement skills acquired in Vocational Schools. they also get difficulty in adjusting to the changes in science and technology and difficult to be trained and develop themselves (Ixiarto & Sutrisno, 2016; Notonegoro, 2010).

The curriculum center examines curriculum policy of Vocational High School and it states that the existence of adaptive subject groups has an impact on learning burden of students in Vocational Schools on one hand. Meanwhile, on the other hand, the impact is reducing the allocation of time for vocational subjects. The subject of the adaptive group in the curriculum of 2013 is called as C1 basic group subject area of expertise. In the standard aspect of content, the addition of basic subject matter in

the field of expertise C1 does not support the vocational material.

Decree of General Director of Primary and Secondary Education No. 130/D/KEP/KR/2017 about Curriculum Structure of Vocational Secondary Education is grouping chemistry subject in a group of basic subjects in C1 Basic Skills Expertise program. Chemistry as a basic subject in the field of expertise is not placed based on vocational subject requirements in each skill of competency. The chemical material needs of vocational schools in each competency of expertise are not the same for each competency of different skills.

Jatmoko (2013) stated that Vocational High School consists of various fields of expertise. The Decree of General Director of Primary and Secondary Education number 7013/D/KEP/MK/2013 previously stipulated chemistry subject included in the marine and fisheries expertise package to have 29 basic competencies. In the package of technology and health expertise, there are 52 basic competencies. Technology and engineering expertise packages have 57 basic competencies. Agribusiness and agrotechnology expertise packages have 37 basic competencies. Each study program has a different expertise that shows differences in the needs of chemistry subjects because it is adjusted to the purpose of forming expertise program competencies.

The aim of chemistry subject is to support expertise competencies in Vocational High School which is related to the suitability for chemical content with the context of expertise competencies. The content referred to the context of education is the chemical curriculum taught. Kusumaningjati & Juhadi (2015) stated that the curriculum is a set of plans and arrangements as guidelines for implementing learning to achieve certain educational goals. Curriculum development is the preparation of plans about the content and material of learning that must be

learned and also how to learn it (Kaimuddin, 2015).

Azizah (2015) stated that the curriculum in Vocational School must be a joint program between schools and industry. Therefore, adjustments or synchronizations between the materials contained in the curriculum with the fields of work which is available at partner institutions can be used as learning equipment for students to achieve the skill mastery required. The students in Vocational High Schools must be prepared seriously in various vocational programs by sharpening adaptive skills. in line with competency needs both personal and social (Johan, 2015).

In this case, the students must be able to master some of the competencies which are needed by the work field by learning various subjects. Chemistry subject has functioned as basic subjects in the C1 field of expertise. The theoretical basic subjects of C1 field of expertise called chemistry have functioned as the subject that support the subjects of expertise and expertise or vocational competency programs. Therefore, the curriculum for chemistry subjects in Vocational High School must be prepared well to make it balance and suitable with the needs of a vocational school and in accordance with respective expertise competencies.

Curriculum mastery is one of the competencies that must be possessed in teaching chemistry. One of its mastery is the knowledge of subject curriculum in the vocational field. This is related to the characteristics of the chemical material which is being taught, the learning objectives and the competency characteristics of the expertise (Khasawneh et al., 2008; Dolfing et al., 2011).

Wiyarsih et al. (2017) stated that chemistry as a basic subject in the field of expertise, essentially it has purpose to support skills program subjects, so that Vocational students are able to use basic chemical knowledge in everyday life, and as a basis for developing competencies in each of their fields of expertise.

Learning chemistry at Vocational High School which is in accordance with the needs of students' expertise will be meaningful. The learning process will be accepted and make students motivated to learn if the material is in accordance with their needs. It is so important to have the ability to map content and mastery of content which is suitable with the vocational context as well as the fact about implementing chemical learning in vocational schools. The process of learning chemical material as the content delivered must be integrated with the competency of expertise program as a context because chemistry subject supports the formation of program competencies. The students of nautical vocational school need more enrichment on the concepts of hydrocarbon and petroleum compound which is related to the fractionation process, the result of petroleum distillation and the impact of the use of fuel oil and the prevention of pollution by petroleum spill.

A previous study which is conducted at one of the Nautical Vocational High Schools in Cirebon found that chemistry learning was not integrated with vocational learning material as well as at Tayu-Pati Nautical Vocational High School. The teacher teaches chemistry learning which only explains the chemical material in general without relating it to the material contained in nautical vocational subjects. Chemical learning that is carried out is included as independent learning, and its function of chemistry subject as a basic subject in the field of expertise has not been fully gained. Chemical learning processes that are not integrated cause students feel bored and assume that chemical material is not important to learn, because there are many chemical materials without any relevance to the competency of nautical skills (Azizah, 2011).

Another obstacle from the result of the study which is conducted by Wiyarsih et al. (2017) found several obstacles faced by chemistry teachers in the vocational school in implementing their learning. There are six teachers of ten vocational school teachers have

not understood the essence of chemistry learning as a support for competency skills which must be developed.

The potential of learning chemistry which is integrated with nautical vocational material has a big possibility to be held. The chemistry that discusses hydrocarbon and petroleum compounds is closely related to vessel engineering vocational subject matter on the subject of types of fuel and lubricants. It is also related to the material of environmental awareness and prevention of pollution on the subject of prevention of pollution by oil spills in the sea.

Seeing the cases and background explanation above, it needs a learning device that can improve students' understanding and can support the demands of the industrial world in accordance with the competence of the nautical merchant ship. One of the learning tools that can be used is teaching the material. During the learning activities that have been going through, the existence of teaching materials especially in Vocational High Schools, it still lacks of a pattern of integration between supporting subjects such as chemistry and maritime expertise program subjects with the competency skills of the nautical merchant ship.

### **Integrated Learning Methods for Vocational Materials**

Integrated teaching materials are the materials that can help a teacher in creating an integrated and comprehensive learning. Integrated means an approach to develop reasoning skills in forming knowledge based on interactions with the environment and its life experience. Fogarty (1991) stated that there are ten integrated learning models. The ten methods or models are such as: (1) fragmented, (2) connected, (3) nested, (4) sequenced, (5) shared, (6) webbed, (7) threaded, (8) integrated, (9) immersed, dan (10) networked. The purpose of developing integrated teaching on nautical vocational material is to improve the understanding of the concepts of hydrocarbons

and petroleum. Therefore, it is necessary to combine the integrated model that presents the Chemical concept and its relevance to other concepts or other disciplines in a theme. Some studies also show that the relevant content of science (chemistry) subject in Vocational High School can be selected to be integrated with the vocational curriculum (Quinn, 2013; Coenders et al., 2010).

### **METHODS**

This research is using research development method or it is called as R & D (*Research and Development*) method. The study was conducted at Tayu-Pati Vocational High School of Nautical. A limited trial research was conducted to 12 cadets of Tayu Vocational High School of Nautical in the grade of XI NKN C, while a broad trial was conducted on 32 cadets in the grade of XI NKN A.

Data collection techniques in this study include interviews, observation, documentation, and questionnaires. Types of data include qualitative and quantitative data. Qualitative data were obtained from interviews, questionnaires on responses of students and teachers, while quantitative data included the influence of the use of instructional materials on understanding students' concepts and responses of students to the use of instructional materials. The instruments developed are in the form of non-test in the form of interview sheets and response questionnaires. The instruments for understanding concept test are in the form of a diagnostic test for understanding *three-tier test* concept. The data were analyzed descriptively and instrument validation.

### **RESULTS AND DISCUSSION**

The research was conducted through four stages, they are such as define, design, develop

and disseminate. The development phase is explained below. such as:

#### Define

The first step in developing teaching materials is called the define step. which includes an analysis of school characteristic. analysis of learning competency. analysis of student need. analysis of concept/material and task analysis. The defining stage is done to determine and define the conditions needed in learning by analyzing learning objectives and material boundaries. The defining stage is also used to establish the basic framework for developing teaching material that is considered as ideal.

#### Design

The result of the analysis from the define stage is used as the basis for carrying out the design steps for teaching material and developing teaching material. The design of teaching materials is concerned about the need of students. The basic design of integrated chemistry teaching materials for nautical vocational materials of commercial vessels on the subject of hydrocarbons and petroleum has

components such as introduction. it consists of cover page. Francis page. introductory page. table of contents. description. prerequisites. instruction for using teaching materials. learning objectives. KI and KD and initial ability checks. The content consists of descriptions. learning activities. and assessments. The closing consists of the key and discussion. glossary. and bibliography.

#### Develop

The development stage is the stage that is carried out to produce a valid or feasible development product. The results of data analysis obtained in this stage are:

#### The Result of Research Instrument Validation

The initial product development (draft I) was validated by five validators. Validation was carried out on (1) teaching materials. which consisted of material assessment and readability assessment. (2) syllabus. (3) lesson plan. (4) response questionnaire. (5) question test of concept understanding. the recapitulation of scores from validation research instruments are presented in Table 1 below:

**Table 1.** Summary of Results of Expert Validation on Learning Devices

No	Device	Validation Value	Criteria	Category
1	Teaching Material	3.72	Valid	Very Good / Excellent
2	Syllabus	3.68	Valid	Very Good
3	RPP / Lesson Plans	3.47	Valid	Very Good
4	Student Responses	3.46	Valid	Very Good

Based on the result which is listed in Table 1. it was concluded that all research instruments have valid criteria. The feasibility assessment of teaching materials uses the evaluation component in the guideline for developing teaching materials which are according to Siddiq (2008). Textbook instruments adapted from BSNP. including components of content feasibility. linguistic feasibility. presentation feasibility. and feasibility of graphics. this is in accordance with Fitri et al. (2013).

#### The effectiveness of Integrated Chemistry Teaching Materials for Vocational Nautical Materials

The effectiveness of the development of teaching material is known based on the results of the analysis of students' understanding of the concept. The achievement of competencies in chemistry subject and integrated vocational subjects is the goal of the learning process which is done. Chemical material that is integrated with vocational material will motivate students

to know more about the function of chemistry subject as the basic field of expertise. Interactive preliminary presentation stimulates the curiosity of students. the use of communicative language and in accordance with the rules of the Indonesian language which is good and correct to facilitate students in understanding the material.

The result of understanding the concepts of students is obtained after students doing a

pre-test and post-test activities. The pre-test and post-test questions consisted of 25 questions in the form of a diagnostic test about understanding three-tier test concept. The improvement of an understanding concept is known through the calculation of normalized gain values between the pre-test and post-test values. The result of the pre-test and post-test values are presented in Table 2 below.

**Table 2.** Pre-test and Post- test Data

Data	Average	Maximal value	Minimal Value	Sign	Normality Data
Pre-test	44.50	56	32	0.034	Normal
Post-test	77.13	84	64	0.015	Normal

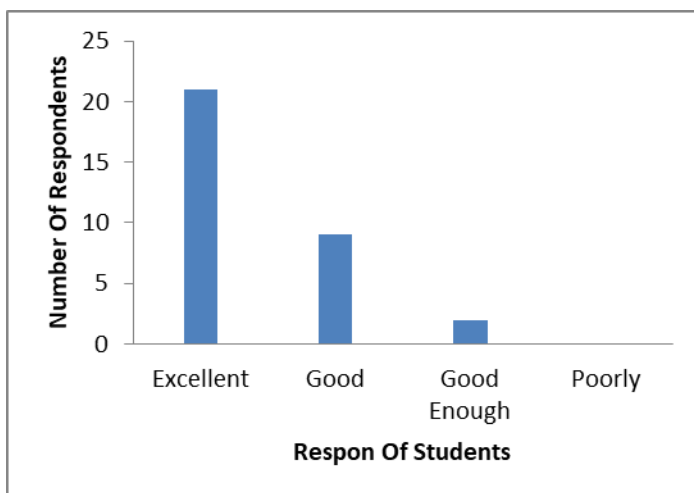
The result of the study shows that the average score of pretest is 44.50 and the average value of post-test was 77.13. The result of the average N-gain analysis is 0.57 and it is included in the medium category. Students' classical learning completeness shows that there are 24 of 32 students get the score above KKM (Minimum Completeness Criteria) 75 (completed).

Hakim et al. (2015) stated the significance of increasing understanding of a concept is using paired sample T-tests. The use of integrated chemistry teaching materials for nautical vocational materials of commercial vessels can significantly improve students' conceptual understanding. The result of the paired test shows that the price of  $t_{count}$  is 19.589 with 31 degrees of freedom. the value of  $t_{table}$  for error is 5% = 1.669. Because  $t_{count}$  is greater than  $t_{table}$ . it means that the learning outcomes of understanding the concepts of students have gained the effective criteria. The result also shows an increase in understanding of the concept of this study in accordance with the results of research which is conducted by Harijanto (2007). he stated that the use of instructional materials products can improve learning outcomes.

The use of integrated chemistry teaching materials for nautical vocational subjects in commercial vessels can improve students understanding of concepts. and this proves that chemistry teaching materials integrated with commercial nautical vocational materials are appropriate for the science learning process. The chemical concepts integrated which are relevant with nautical vocational materials of commercial vessels in teaching materials and chemistry learning will be useful. and it is because science is combined with the teaching of other concepts and can make chemistry becomes more meaningful for students (Najib & Elhefni, 2016) and will be more in line with the needs of learners (Fogarty, 1991).

### **The Result of Student Responses Toward Teaching Material**

The result of data analysis on the student response shows that out of 32 students and 21 participants gave a very good response. 9 students gave good responses and 2 students gave quite good responses. The full result of the student response questionnaire is presented in Figure 1 below.



**Figure 1.** Diagram of Students Response Toward Teaching Material

Figure 1 shows that overall the students in large class test gave a very good response to the use of chemically integrated teaching materials for commercial nautical vessels. The results obtained 94% can be classified in the category of agree and strongly agree.

Positive results are gained by the fact that some of the students feel interested in learning by using integrated chemistry teaching materials for nautical vocational material. Learning material that is not directly related to real life (contextual) can increasingly shape the assumption of students that chemical material in vocational schools is not important.

Hsu (2006) stated that most of the learning activities which do not start from real life can make students unable to apply the connection of what is learned to solve real-life problems. Through integrated teaching materials, nautical vocational material, students can understand the functions of chemical subjects. Chemistry subjects as a basis for expertise that can accommodate vocational material which is called ship machiner, and it is related to the types of fuels and lubricants which are the result of petroleum fractionation.

The impact of combustion of hydrocarbons and petroleum is also very interesting to be learned because it is closely

related to vocational material which is called as environmental care and pollution prevention. IMO has its own attention since 1973 so IMO ASSEMBLY was formed to coordinate pollution and control of marine pollution from ships (Knudsen & Hassler, 2010).

The last stage of this research is disseminated (spread). This stage is the final stage of development research. The purpose of this stage is to disseminate teaching materials that have been developed on a wider scale, for example, other classes, other schools or by other teachers. In this study, the distribution stage is carried out by publishing through scientific journals/articles and implementing teaching materials at school.

## CONCLUSION

The chemical teaching material that has been developed is an integrated chemical teaching material with the commercial nautical ship vocational material and it has been validated or valid. The validity value for the material is 3.70 and the validity value of the media is 3.65 and the overall validity which is obtained by the teaching material is 3.68. Teaching materials have been declared very

feasible by the validator in terms of content. language. presentation. and graphics.

Based on the responses of students from 32 students. there are 21 participants gave a very good response. 9 students gave good responses and 2 students gave quite good responses. Based on the results of the study and discussion. it can be concluded that the average n-Gain for understanding the concept has increased. This shows that the use of chemistry teaching materials integrated with the nautical vocational materials of commercial vessels increases can significantly improve students' conceptual understanding. The paired test results show that the price of  $t_{count}$  is 19.589 with 31 degrees of freedom. the value of  $t_{table}$  for error is 5% = 1.669.

## REFERENCES

- Azizah. D. (2011). Pola Integrasi Kimia di SMK Pelayaran. *Laporan Studi Kasus*. Bandung: Jurusan Pendidikan Ilmu Pengetahuan Alam Konsentrasi Kimia. UPI Bandung.
- Azizah. M. (2015). Strategi Kerja-sama Sekolah Dengan Dunia Usaha Dan Dunia Industri (Du/Di) Dalam Meningkatkan Kompetensi Lulusan Pada SMK Negeri 3 Banda Aceh. *Jurnal Administrasi Pendidikan: Program Pascasarjana Unsyiah*. 3(2). 148-158
- Coenders. F., Terlouw. C., Dijkstra. S., & Pieters. J. (2010). The Effects of the Design and Development of a Chemistry Curriculum Reform on Teachers' Professional Growth: A Case Study. *Journal Science Teacher Education*. 2(1). 535-557.
- Dolfing. R., Bulte. A.M.W., Pilot. A., & Vermunt. J.D. (2011). Domain Specific Expertise of Chemistry Teachers on Context-Based Education About Macro-Micro Thingking in Structure-Property Relations. *Research in Science Education*. 42(3). 567-588.
- Fitri. L.A., Kurniawan. E.S., & Ngazizah. N. (2013). Pengembangan Modul Fisika Pada Pokok Bahasan Listrik Dinamis Berbasis Domain Pengetahuan Sains untuk Mengoptimalkan Minds-On Siswa SMA Negeri 2 Purworejo Kelas X Tahun Pelajaran 2012/2013. *Jurnal Radiasi*. 3(1). 19-23.
- Fogarty. R. (1991). *The Mindful School. How to Integrate the Curricula*. Illionis. USA: Palantine Skyliht Publishing. Inc.
- Hakim. F., Susilaningsih. E., & Cahyono. E. (2015). Pengembangan Modul Kimia Terintegrasi Karakter Islami pada Materi Reaksi Redoks. *Journal Of Innovative Science Education*. 4(1). 1-17.
- Harijanto. M. (2007). Pengembangan Bahan Ajar Untuk Peningkatan Kualitas Pembelajaran Program Pendidikan Pembelajar Sekolah Dasar. *Jurnal Didaktika*. 2(1). 216-226.
- Hsu. Y. (2006). Lesson Rainbow: the Use of Multiple Representations in an Internet-Based. Discipline- Integrated Science Lesson. *British Journal of Educational Technology*. 37 (4). 539 – 557.
- Ixtiarto. B. & Sutrisno. B. (2016). Kemitraan Sekolah Menengah Kejuruan Dengan Dunia Usaha dan Dunia Industri. *Jurnal Pendidikan Ilmu Sosial*. 26(1). 57-69.
- Jatmoko. D. (2013). Relevansi Kurikulum SMK Kompetensi Keahlian Teknik Kendaraan Ringan Terhadap Kebutuhan Dunia Industri di Kabupaten Sleman. *Jurnal Pendidikan Vokasi*. 3(1). 1-13.
- Johan. A.B. (2015). Peran Guru Profesional Dalam Memenuhi Kebutuhan Industri. *Jurnal Akademik*. 1(7). 15-26.
- Kaimuddin. (2015). Pengembangan Kurikulum Perguruan Tinggi. *Jurnal Ta'dib*. 8(2). 19-38.
- Khasawneh. S.A., Olimat. M.M., Qablan. A.M., & Tineh. A.M.A. (2008). Measuring the Perceptions of Vocational Education Students Regarding the Application of National Vocational



- Teacher Standard in the Classrooms: The Key to Human Resource Education in Jordan. *IJAES*. 2(1). 24-37.
- Knudsen. O.F. & Hassler. B. (2010). IMO Legislation and Its Implementasi; Accident Risk, Vessel Deficirncies and Nation Administrative Practices. *Journal Marine Policy*. 9(6). 1-7.
- Kusumaningjati. S. & Juhadi. (2015). Pengembangan Buku Teks IPS Kelas VII Semester II Berbasis Kurikulum 2013. *Edu Gepgraphy*. 3(6). 54-60.
- Najib. D.A. & Elhefni. (2016). Pengaruh Penerapan Pembelajaran (*Meaningfull Learning*) Pembelajaran Tematik IPS Terpadu Terhadap Hasil Belajar Siswa Kelas III MI Ahliyah IV Palembang. *Jurnal Ilmiah PGMI*. 2(1). 19-28.
- Notonegoro. A.Y. (2010). Model Kompetensi Lulusan Sekolah Menengah Kejuruan (SMK) berbasis Kompetensi Dunia Usaha dan Dunia Industri (DUDI). *Jurnal Penelitian Kebijakan Pendidikan*. 8(1). 1-19.
- Quinn. T.T. (2013). An investigation of curriculum integration in a vocational school setting: a qualitative study. *Doctoral Theses*. Boston (Mass): Northeastern University. <http://hdl.handle.net/2047/d20003039>.
- Siddiq. D.M. (2008). *Pengembangan Bahan Ajar*. Direktorat Jendral Pendidikan Tinggi Departemen Pendidikan Nasional. Jakarta.
- Thiagarajan. S.. Semmel. D.S.. & Semmel. M.I. (1974). *Instructional Development for training Teachers Of Exceptional Children*. Blomington Indiana: Indiana University.
- Undang-undang No. 20 Tahun 2003 Tentang Sistem Pendidikan Nasional.
- Winangun. K. (2017). Pendidikan Vokasi Sebagai Pondasi Bangsa Menghadapi Globalisasi. *Jurnal Taman Vokasi*. 5(1). 72-78.
- Wiyarsih. A.. Partana. C.F.. & Purtadi. S. (2017). Pelatihan Pengembangan Kimia Terintegrasi Konteks Kejuruan untuk Meningkatkan Profesionalisme Guru SMK di DIY. *Jurnal Pengabdian Masyarakat MIPA dan Pendidikan MIPA*. 1(2).70-76.
- Yu. X. (2013). A Comparative Review in Chinese Vocational Education and Training System. *The Online Journal of New Horizon in Education*. 3(2). 1-6.