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Physics Laboratory Investigation of Vocational High School Field Stone and Concrete Construction Techniques in the Central Java Province (Indonesia)

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Abstract
The investigation aims in this study were to uncover the observations of infrastructures and physics laboratory in vocational high school for Stone and Concrete Construction Techniques Expertise Field or Teknik Konstruksi Batu dan Beton (TKBB)'s in Purwokerto Central Java Province, mapping the Vocational High School or Sekolah Menengah Kejuruan (SMK) in the expertise field of TKBB that was there in Central Java Province, viewing the physics teacher's profiles of vocational high school, and the implementation of physics laboratory in vocational high school for TKBB's expertise field. This study was focused on the Vocational High School (SMK) in expertise field of TKBB, by involving about 26 physics' teachers (N = 26) from 13 SMK from seven districts in the Central Java Province, Indonesia, which is consisted by 6 private and 7 public SMK. The study were conducted by observations and semi-open written interview. The results are showed that 46.16% of physics' teachers in vocational high school were not implementing the practicum in the physics learning and 53.84% of teachers stated they were implementing the physics practicum. The reason of the teachers to did not implement the practicum were: 1. the lack of practicum equipment availability, 2. the lack of school hours, 3. the lack of ability of the teachers to design the practicum. From 14 teachers of 26 teachers who were involved in the study are stated that they were implementing the physics practicum in one semester, it is obtained the results if there were a variation of the number of practicum implementation, namely: 1 times, 2 times, 3 times and ≥ 4 times, by the percentage of each about: 7,14 %, 7.14%, 71.42% and 14.28%.
Keywords: vocational high school, field of stone and construction techniques, physics practicum.

• Introduction

Education of vocational have the aims to improve the intelligence, knowledge, personality, character, and skill of the students to live independently and join the further education in accordance with its vocational program (Curriculum of Sekolah Menengah Kejuruan Tujuh Lima 1 Purwokerto, 2009). The curriculum structure of Vocational High School (SMK) were consisted by three groups of subjects, namely normative group, adaptive, productive. The expertise spectrum of vocational high school in Indonesian were consisted by six subject's areas of expertise, the three of them were Technology and Engineering, Health, Agribusiness and Agro-Technology (Agriculture) and it was supported by adaptive physics subjects.

Physics subjects for the Vocational High School (SMK) or Vocational Islamic High School (Madrasah Aliyah Kejuruan (MAK)) were aims to equip the students with the basic knowledge of the nature laws, where the mastery was to be the basis and the ability requirement, that is functioned to lead the learners to achieve the competency of their program expertise. In addition, the subject of physics is prepared the learners to be able to develop their expertise program at the higher education level. The mastery of the physics subject was facilitating the learners to analyze the processes that is associated with the basics of the equipment performance and the device that was functioning to support the establishment the competence of expertise program.

In vocational high school curriculum, it is mentioned that the physics subject is intended in order the students have the abilities as follows: (1) establish the positive attitude towards the physics, by realizing the regularity and beauty of the nature, as well as exalting the greatness of Almighty God, (2) fostering the scientific attitudes, namely honest, objective, open, resilient, critical and can cooperate with others, (3) developing the experience to be able to formulate the problem, proposing and testing the hypotheses through the experiment, designing and assembling the experimental instruments, collecting, processing, and interpreting the data, and communicating the results of the experiment orally and written, (4) developing the ability to reason in analysis thinking of inductive and deductive, by using the concepts and principles of physics to explain the natural events and resolve the problems both qualitatively and quantitatively, (5) mastering the concepts and principles of physics and have the skills to develop the knowledge, skills and a self-confident as a preparation for continuing the education on the higher level, as well as to develop the science and technology, (6) mastering the basic concepts of physics that is directly supported the competencies achievement of their expertise's program, (7) applying the basic concepts of physics to support the competencies implementation of their expertise's program in dialy life, (8) applying the basic concepts of physics to develop their expertise on the program ability, on the higher level.

The physics learning as a part of the science was not enough by only to explain the theory, but it must

be supported by the practicum. The physics practicum activity was encourage the students to use actively their senses to conduct the investigation. This mattter was in accordance with the NSES, 1996 which is stated that the science learning was an active process, where the students were active physically and mentally in understanding the science, students can be engage their senses to describe an object or phenomenon of the nature, actively asking, acquiring the knowledge from the various sources, submitting their result thought to explain the object or natural phenomena, testing by any various ways of its explanation and discussing its explanation result with their teacher and friends.

Garnett and Hackling (1995) stated that the laboratory would be contributing towards the improvement of students' concept understanding, the skill and application technique, and the ability to analyze the relationship between the variable. In addition, the laboratory was also contributing towards the improvement the student's skill, including to: scientific thinking, observation, creative thinking, interpretation of event collection, data and analysis, and problem solving (Ausubel, 1968). According to Hofstein and Naaman (2007), the lab application were aims to improve the students' science process, problem solving skill, interest and attitude, toward the scientific approach in accordance with the goal of science education.

Accordance with that matter above, so that the physics learning in vocational high school should be supporting by the practicum activity that can encourage the students to play role actively in understanding the physics. In teaching, the students should be actively involved and thorough, as the practicum of science, so that the students can be understood the values of science, including to: hard work, critical thinking and the other science values that is distinguished it with other knowledge (NSTA, 1998). Science was the result of the human activities, it can be form as knowledge, idea, and concept that is organized on the environment, that is gained from the experience through the a series of scientific process, such as investigation, preparation and testing of ideas (Departemen Pendidikan dan Kebudayaan, 1994). According to Rutherford *et.al* (1990) that science was a process to obtain an information through the *empirical method*; science was an information that is obtained through the investigation that was arrangement logically and systematicly; and science was a combination of critical thinking processes that is produced a reliable and valid information.

The education of science has a special characteristic that is contained a value, not only concerned the result but also paid attention to the process. The main results of science education ideally should be included a mastery of the product (concept, principle, theory, and law), a number of skills (process, generic, life skill), and the scientific attitude, which can be developed with the inquiry. But in the reality, it was found a lot of failure in inquiry learning. That failure was due to the weakness in the inquiry learning that was along this had been carried out by the teacher. According to Wenning (2006), these weaknesses were:

1. The process of *scientific inquiry* is often introduced as an unorganized combination, it meant that the implementation of stages on the inquiry activity is conducted partially, eventhough it has an interconnected procedure, some teachers were implementing an inquiry process irregularly, where the implementing inquiry activity is not based on the experience and learning ability of students.
2. The teacher does not know the difference between each stages in the inquiry process, so that the teacher can not provided an appropriate learning to the students, in accordance with the student's ability.
3. The teacher does not have any enough knowledge about: how to teach students to do the science, this matter is associated with the teacher's experience when he/her was studying in the college, that one of because the lecturer does not teach to teacher's candidate.
4. Some of teachers were having a lack preparation to conduct an inquiry, it is caused the laziness in doing a preparation, as well as the presence of excessive self-confidence.

In addition to what has been described by Wenning, teachers also use the lab as a traditional laboratory applications in schools with a deductive approach. Whereas in a laboratory environment, the various skills required of students can not be improved only through trial closeended (deductive). According Hofstein and Lunetta (2003), students work as technicians "cookbook" in the lab activities that focus on improving low-level skills. Students are given very little opportunity to have a discussion experimental, to build and test hypotheses or to design experiments and authentic experiment (Lunetta & Tamir, 1979). Laboratories should not only aim to strengthen the theoretical knowledge, but also allows students to find their own knowledge. Wilkinson and Ward (1997) also revealed that science teachers do not realize that the various experiments that they do have to have a different purpose. Laboratory applications can use the deduction (verification), induction, and research-based approach.

But the reality in the field of physics learning is done with laboratory experiments, students simply do as directed practicum and practicum teacher instruction. Stage by stage just as the students understood what to do does not make sense why the stage was done. students are only required that the results of the data in accordance with existing practice in theory. Thus, it is clear that the activities of the laboratory failed to improve psychomotor skills of the students and help them reconstruct their own knowledge (yesilyurt, Bayraktar and Erdemir, 2004). Weaknesses mentioned above need to be addressed by applying the science inquiry learning activity hierarchy (Hierarchy of inquiry). In addition, based on research results Memon, 2007 (in Faize, 2011),

the science teacher, armed only theoretical aspects of pedagogy but little emphasis on teaching methods using lab. Debriefing in doing practical training for teachers is lacking, the consequence is that the shortage of science teachers teaching skills using practical methods that effectively is needed in understanding the concept of the student.

Based on the hierarchical description of inquiry developed by Wenning, laboratory activities occupy an important role, make observations, develop questions, establish procedures, experiment to answer the hypothesis and report the results. So that teachers can teach students to build her potential, teachers should obtain sufficient provisioning through learning by example and learning by doing which they will develop a learning process based on the experience they have acquired. Science learning process shift from teacher-centered methods to switch to student-centered method based activities to encourage and develop a spirit of inquiry in students, an effort to make students aware of and understand how scientists work, and also equip and prepare students for life and for their careers in science and technology led to the need for skill development, Akinbobola, AO, (2006).

Expression of the teachers in the activities of a preliminary study conducted by researchers of the non-performance of the lab because of limited equipment, lack of class hours and the difficulty in designing lab teacher. Some of the difficulties are: (1) determine the suitability between competency standard and basic competency with practical purposes, (2) the ability to design measurement technique, (3) develop practical procedures, (4) designing tools and (5) make the referral question. Based on the results of the questionnaire showed that most of the SMK physics teachers reported to have never received training on designing practicum physics based skill competency needs both held in schools conducted by the Department or the collaboration between the school and The Institute for Teachers and Education Personnel or Lembaga Pendidik dan Tenaga Kependidikan (LPTKs) for example in the Partnership Program between the teacher - lecturer.

Teachers in designing practical difficulties can be seen from the absence of the teacher's work is novelty, application technology, useful for vocational students, utilize existing materials in the surrounding environment as lab materials in the form of practical guidance, this suggests that teachers lacked creativity. The results of preliminary studies also found that the implementation of practical activities in vocational less supports competency areas of expertise. Teachers do not develop customized materials physics lab with expertise in program where teachers teach, and just use the existing instruction lab activities in the module as is done in high school physics teacher. Preliminary research data showed that as many as 77% of the number of teachers who were respondents stated that in carrying out the practical use lab kits on the market (spring, swing mathematical, and fluid). Practicum has been done together with practical activities in high school, and will be verified. Even though the teacher realized that the real learning in vocational physics lab methods should be supported, and there should be mapping lab materials to support productive subjects in the field or program expertise in accordance with the purpose of physics subjects in the curriculum. Based on data obtained as much as 46% of teachers agreed when the material vocational practice tailored to the needs of expertise, 46% disagree and 8% did not give an answer.

Teachers in their profession must fulfill the Academic Qualification Standards and Competencies Teachers as defined in the Regulation of the Minister of National Education No. 16 of 2007. The standard was developed as a whole teacher competence of the four main competencies; pedagogical, personality, social and professional. Fourth integrated competency in the performance of teachers, some teachers' professional competence related physics lab physics: (1) understand the concepts, laws, and theories of physics and its applications in a flexible, (2) describes the application of the laws of physics in technologies associated with the physics especially those that can be found in everyday life, (3) a creative and innovative in the application and development of the field of physics and related sciences, (4) using measuring tools, props, calculators, and computer software to enhance learning in the classroom physics, laboratory and field, (5) to design physics experiment to study or research purposes.

Learning physics as part of science is essentially aimed at fostering students' intellectual competence such as independent learning, problem solving, decision making and critical thinking (American Association for the Advancement of Science (AAAS), 1993; National Research Council (NRC), 1996. According to Tan & Temiz, (2003), the fundamental purpose of teaching science today is to educate students to conduct research, explore, investigate, make connections between everyday life with topics of science, using scientific methods to solve problems and see the world through the eyes of a scientist. so that learning science is able to give effect to the expected capabilities, it is necessary to think about how the learning process is conveyed to students, (Utari, 2010). According to Millar (2004, p.2), work practice or practice is defined as:

> "any teaching and learning activity which involves at some point the students in observing or manipulating real objects and materials".

Practical work in this sense includes experimental, fieldwork work and laboratory work. Article Millar (2004, p.1) two main aims of science education on the role of practical work in the teaching and learning of science summed up broadly:

- To help students gain an understanding of as much of the established body of scientific knowledge as is appropriate to their needs, interests and capacities
- To develop students' understanding of the methods by which this knowledge has been gained and our grounds for confidence in knowledge about science.

The first aim is about understanding the content of science and the second is about understanding the nature of science. An understanding of how science and the scientific community work will help students learn the content of science better. This includes understanding of the processes involved in the conducting of a scientific enquiry, the intellectual reasoning used by scientists to analyse data and produce evidence in order to make a claim or propose a theory, and how this evidence is verified by the scientific community.

Tamir (1991) identified five main reasons for school science lab work are: 1. Work lab provides the opportunity for students to understand and manipulate the nature of science that complex, abstract and encourage the effective conceptual changes, 2. Working with the investigation to help students develop the knowledge procedural, encourages problem solving and analytical skills as well as develop scientific attitudes and values such as honesty, patience, understanding the limitations of the experimental and be able to critically assess the results, 3. Develop critical thinking skills and creative thinking, 4. Work laboratory help identify, diagnose misconceptions students, 5. Motivate practical work and interests of students in science.

Practicum is defined as one method that serves to clarify the concept of learning through contact with tools, materials or natural events directly, increasing the intellectual skills of students through observation or complete information retrieval and selective support practical problem solving, training in problem solving, applying knowledge and skills to the situation at hand, trained in designing experiments, interpret the data, and foster scientific attitude (Departemen Pendidikan Nasional, 2007).

The purpose of investigation in this study is to reveal the physics practical implementation by teachers in vocational school, vocational school physics teacher's profile in Indonesia, the problems faced by teachers in implementing practical, teachers' perceptions of the development of the physics lab that are tailored to the needs of competency skills.

2. Method

This study is an analysis of the needs of program development capabilities in designing practical physics teacher competency requirements based on vocational skills. The method used is the observation in two vocational school in Purwokerto and written interview involving 13 SMK from 7 districts in Central Java Province, Indonesia. vocational schools that involved is consists of 6 and 7 Private SMK with 26 physics teachers (N = 26). In this study reveal vocational physics teacher profiles and interviews comprehensive written material about: profile practical implementation of physics in vocational high school expertise stone and concrete construction techniques, vocational school physics teacher response to the development of vocational topics in physics lab, and master response against development physics lab competency requirements based on the expertise of stone and concrete construction techniques. The instruments used in the study is containing a semi-open questions. Data and results of semi-open interviews that will be obtained in this study are as follows: 1. observations vocational schools in Purwokerto, 2. data on vocational technical expertise stone and concrete construction techniquesmin Central Java Province engaged in the research, 3. map location SMK expertise of stone and concrete construction techniques that exist in Central Java Province, 4. data profile of teachers involved in the study, 5. profile of physics in vocational practical implementation on expertise stone and concrete construction techniques, 6. vocational school physics teacher's response to the development of the physics lab topics the SMK, 7. Teachers' response toward development physics lab-based competency requirements expertise stone and concrete construction techniques.

- **Result And Discussion**

Based on the existing curriculum at SMK Negeri 2 Purwokerto and SMK Tujuh Lima 1 Purwokerto stated that three of the eight physical competence in vocational skills stone and concrete construction techniques are as follows: (1) capable to the basic concepts of physics that directly support the achievement of program competencies expertise, (2) apply the basic concepts of physics to support the implementation of the program competency skills in everyday life, (3) applying the basic concepts of physics to develop expertise on the program's ability higher level. The description indicates that the learning and application of physics concepts strongly supports the attainment of skills while learning method that serves to clarify the concept through contact with tools, materials or natural events directly is the practicum.

The Results of observation at SMK Tujuh Lima 1 Purwokerto and SMK Negeri 2 Purwokerto on the implementation of infrastructure and the implementation of the physics lab was obtained as described in Table 1.

Table 1. Observations for infrastructure and implementation of practical physics in vocational expertise stone and concrete construction techniques in Purwokerto

No.	explanation	SMK Tujuh Lima 1 Purwokerto	SMK Negeri 2 Purwokerto
1.	Status of SMK	Private	Public
2.	room of physics laboratory	available (belonging to the chemical laboratory)	available
3.	laboratory equipment	available (never used)	available (stored in the tools cupboard school)
4.	type physics lab equipment owned	-Kit mechanics : mathematical swing , the object on an inclined plane - Kit electricity and magnetism - Kit wave - Kit temperature and heat - Optical Kit	- Kit mechanics : mathematical swing , the object on an inclined plane - Kit electricity and magnetism - Kit wave - Kit temperature and heat - Optical Kit
5.	practical implementation	not implemented	implemented
6.	the number of practical activities which is implemented	-	1 times in one semester

Written interviews involving 26 respondents physics teachers (N = 26) from 13 SMK, namely SMK seven and six private vocational school in seven districts, Central Java Province. SMK involved in focusing on areas of expertise concrete and stone construction techniques. Klaten district (one of the seven districts) has four areas of expertise SMK with stone and concrete construction techniques as well as the number of teachers involved as many as seven people. Detailed description SMK name, type of school, the district and the number of teachers involved are shown in Table 2.

Table 2. Vocational expertise stone and concrete construction technique in Central Java Province, Indonesia

No.	Name of school	Type of School	Region, Regency and post code	Number of Teachers
1.	SMK Negeri 2 Purwokerto	Public	Banyumas, 53116	2
2.	SMK Tujuh Lima 1 Purwokerto	Private	Banyumas, 53143	2
3.	SMK Negeri 1 Wanareja	Public	Cilacap, 53265	2
4.	SMK Negeri 2 Cilacap	Public	Cilacap, 53212	3
5.	SMK Negeri 2 Kebumen	Public	Kebumen, 54315	3
6.	SMK Negeri 1 Purworejo	Public	Purworejo, 54101	2
7.	SMK YPP Purworejo	Private	Purworejo, 54171	2
8.	SMK Negeri 1 Klego	Public	Boyolali, 57385	2
9.	SMK Tunggal Cipta Manisrenngo	Private	Klaten, 57485	1
10.	SMK Kristen 1 Klaten	Private	Klaten, 57417	2
11.	SMK Negeri 2 Sragen	Public	Sragen, 57212	1
12.	SMK Muhammadiyah 4 Klaten Tengah	Private	Klaten, 57419	2
13.	SMK Muhammadiyah 1 Klaten Utara	Private	Klaten, 57434	2
Total of Teacher				26

Number of vocational schools described in the data Table 2, scattered in the southern part of Central Java Province on the west end of the province of West Java and the Eastern end until the borders of East Java Province. The purpose of the seven electoral districts is that the data obtained represent the opinions of teachers as a whole.

Teachers involved in the interviews consisted of 12 male teachers and 14 female teachers. Academic qualifications teachers have a bachelor's is 88.46% 11.53% S1 and S2 are graduates. Of the overall 84.61% of teachers involvedare teachers with academic graduates of undergraduate education, while 15.38% are non-educational graduate with teachers working masses between 3-34 years. Profile of teachers involved in the full interview is shown in Table 3.

Table 3. Profile physics teacher at SMK expertise stone and concrete construction techniques (N = 26)

No.	Description		Number of eachers	Percentage
1.	Gender	Males	12	46,2 %
		Females	14	53,8 %
2.	Years level(s) currently teaching	Grade X	4	15,4 %
		Grade XI	3	11,5 %
		Grade XII	4	15,4 %
		Grade X-XI	2	7,7 %
		Grade XI-XII	5	19,2 %
		Grade X-XI-XII	8	30,7 %
3.	Teacher qualifications	Diploma 4	-	-
		Masters S1	23	88,46 %
		Masters S2	3	11,53 %
4.	Academicgraduates	Undergraduated education	22	84,61%
		Non-undergraduated education	4	15,38%
5.	Years of teaching experience	< 5 years	1	3,8%
		5 – 10 years	15	57,69%
		a. ears	6	23,07%
		> 20 years	4	15,38%

The results of the semi-open interviews on practical implementation profile of physics, practical implementation in one semester, lab equipment used in Vocational Expertise Stone and Concrete Construction Engineering found that 14 teachers (53.84%) stated carry out practical work. Teachers carry out practical work 3 times in one semester recorded 71.4% of the number of teachers who carry out practical work in physics learning, are set out in Table 4.

Table 4. Profile of Physics Practical Implementation in Vocational Expertise Stone and Concrete Construction Techniques

No.	Description	Teacher's responses	Number of teachers	Percentage
1.	Teacher carry out practical in teaching physics	Answer: Yes Reasons: Student can better understand about concept Student can apply the concept in daily life No reason	14 8 6	53,84% 28,57 % 42,85%
		Answer: No Reasons: • Practicum tools incomplete or not available yet. • Hour of lessons less (2 x 40 minutes per week) • The ability of teachers less in carrying out practical	12 8 3 1	46,16% 66,66% 25% 8,33%
2.	Teacher do practrical in one semester	1 time 2 times 3 times > 4 times Reasons: Not all topics of physics must be supported by practical activities	1 1 10 2	7,14% 7,14% 71,4 % 14,28%
3.	Tools of pysics practical (kit) that school have, where the teacher is teaching	-Kit mechanics -Kit Electricity and magnetism -Kit Fluid motion -Kit wave -Kit Temperature and heat -Kit optical -Kit thermodynamics	13 11 8 4 1 4 4	50% 42,30% 30,76% 15,38% 3,84% 15,38% 15,38%
4.	Physics lab topics that have been implemented in learning physics	- Mechanics - Electrical and magnets - Fluid motion -wave -Temperature and heat -optical -Thermodynamics	14 9 12 10 - 4 -	100% 64,28% 85,71% 71,42% - 28,57% -

The results of the study reveal the teacher's response to the development needs of competency-based physics lab acquired expertise that 88.46% agree. Of the number of teachers who agree 39.13% gave the reason that the student is able to apply physics concepts in the field of skills learned. While the reason teachers do not agree with the development of physics-based practicum adalalah skill competency needs of teachers fear that it is too difficult for students. Materials and competency-based physics lab media skills that can be developed in the field of construction engineering expertise stone and concrete is natural sand and concrete non sand. Topics lab made of natural sand and concrete non sand can be developed from the results of research, but in accordance with expertise in vocational fields. Physics lab materials which can be implemented by vocational teachers include examination of the physical properties of lightweight concrete non sand (no-fines concrete) such as specific gravity, density corresponding Purwandari (2009), attenuation of sound waves, according research Purwandari (2010), the heat flow in concrete, thermal conductivity, temperature insulation according to the results of research Purwandari (2011). The results obtained written interview that 84.46% of teachers agreed with the development of practical uses natural sand and concrete non sand.

- **Conclusion**

Learning physics at SMK should be supported by activities in the physics lab practicum. Physics lab topics can be developed and adapted to the existing competence in vocational skills so that students are better able to apply physics concepts in the field of skills learned. Teachers can design their own lab equipment and lab materials that match the topics developed. In the field of expertise of Engineering Construction Stone and Concrete can be developed using the lab topics and media materials natural sand one concrete aggregate and non Logawa river sand. Lab materials can also be developed from the results of the study are in accordance with the competence and the material studied physics at CMS. Teachers need to be trained to improve the ability to design practical physics. The training materials will be given to teachers include: (1) Determine the suitability between kompoetensi standard and basic competency with practical purposes, (2) Designing measurement techniques, (3) Develop practical procedures, (4) Designing tools and (5) Make referrals question . In addition, CMS physics teacher should also be able to analyze Competence Basic Physics and Basic Competence Expertise and competence to bind both the physics lab in order to plan appropriate to the needs of competency skills.

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