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STEM BASED EDUCATION FOR FUTURE LEARNING: CASE STUDY IN SMK UNGGULAN TERPADU PGII BANDUNG

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ABSTRACT

This research aims to investigate of implementation STEM education in SMK Unggulan Terpadu PGII Bandung. The research used the qualitative case study approach. This research took place at SMK Unggulan Terpadu PGII Bandung. The informants in this research were the Vice Principal of the curriculum field in SMK Unggulan PGII and Lecture of Informatics Engineering. The data were collected through observations, in-depth interviews, and documentation. The technical analysis of the data referred to the analysis of Miles & Huberman interactive model, including data collection, data condensation, data display, and drawing and verifying conclusions. The result shows that STEM Education leads students to be able to solve problems, innovative, logical thinking, and insightful technology. So STEM will be implemented through: (1) Scientific-based learning; and (2) Achievement of Learning through Sustainable Learning.

Keywords: STEM, education, vocational school, curriculum, learning.

INTRODUCTION

Global competition becomes a serious threat to the people of Indonesia, especially with the policy in accepting workers from various countries without any conditions. This requires Indonesian workers to have the minimum ability to compete with foreign workers. The readiness of Indonesian workforce in global competition is determined by several aspects, such as: minimum skill competence, professional certification, prototype and self profile, and recognition of graduate education diploma. These aspects must be at least owned by prospective workers who want to apply for jobs in the business / industry (DUDI). In addition, the prospective worker must have a distinctive Indonesian attitude as a plus, as most foreign workers have capabilities far above the average of Indonesian workers.

Working competition is getting stringent in finding jobs because the State has signed cooperation agreements with other countries, including ASEAN and Asia-Pacific. Financial Services Authority of Indonesia (OJK) revealing the challenges facing the ASEAN Economic Community (MEA) is very fierce. Chairman of the Board of Commissioners OJK, Muliaman D Hadad (in sindonews.com, 2016) said that The President hopes the Indonesian society can competitively compete because all the people in ASEAN countries are becoming competitors. Thus graduates must have a qualified stock in order to compete with other countries.

Vocational schools are an alternative to graduates who are competent in their field. One of the goals of establishment of vocational school is to improve intelligence, knowledge, personality, noble character, and skills to live independently and follow further education in accordance with vocational (Article 26, paragraph 3 PP 19 year 2005). Indonesia prepares of qualification framework as a reference of competencies that must be mastered by students. KKNI (National Qualification Framework of Indonesia) requires that vocational schools graduates should have competencies equivalent to level 2, namely: able to perform a specific task; have basic operational knowledge and factual knowledge of specific work areas; are responsible for their own work and can be given the responsibility of guiding others. SMK graduates are expected to compete with other equivalent workers through the achievements of KKNI that have been designed.

The role of vocational education is very strategic in preparing a professional workforce. Vocational education has an orientation in shaping life skills consisting of: training for students to master the competencies required by business / industry (DUDI), knowledge of entrepreneurship, and life skill. Experience and achievement of student life skills can help in reducing unemployment and improving one's economy (Abdulmajid, 2015). Thus it is required an effective

learning method so that the achievement of the formation of life skills of graduates can be achieved well.

STEM-based learning (Science, Technology, Engineering, and Mathematics) becomes an alternative to fulfilling life skills of graduates. These four aspects are the solution to construct real-life problems by simulating problems into problem-based learning methods. Students are required to unite concepts from various aspects. If you want to finish from school, students can practice the concept that has been disektual when in school.

Application of STEM-based learning makes it easier for students to think constructively and able to apply abilities in various fields. This constructive thinking is very useful when dealing with complex problems. Students are familiar with the pattern, so as to solve the problem well. The ability of problem solving is needed for graduates in the 21st century to facilitate keterserapan in the world of work.

The ability of problem solving is also obtained through learning outside the school. Learning in industrial premises is an effective way to improve students' skills. This principle of learning applies progressivism, which is learning in the work environment. Implementation of Industrial Practice (PI) is very suitable to obtain a competence for students. The result of the students' competence after following the PI program is able to show the cognitive, affective, and psychomotor development (Majid, N.W.A., 2015).

Implementation of PI for students in SMK is very important, because it can support the readiness of student work. Although students also have to improve the competence skills that are taught in school. The higher the experience of industrial work practice and the competence of learners together, the higher the readiness of the students work (Majid, N.W.A., 2013).

Technology is becoming the necessity of all fields, especially integration with science makes the use of technology felt by society. Especially in the world of education, technology becomes an alternative to collaborate in the curriculum. Also expected with the help of technology can create a global environment that places students as learning centers, has many learning resources and learning facilities electronically (Abdulmajid & Setiadi, 2015).

Technology for penungjang education growing, especially with the emergence of learning management system (LMS). The concept of LMS is to integrate online-based learning without space, distance, and time limits. In addition LMS can support student center learning and distance learning (Rochmah, E., & Majid, N.W.A., 2017). Application of this technology that should be able to support in learning in the school environment.

Application of science-based learning and technology in the school environment is very important to prepare students in the face of

life in modern society. It can be a stakeholder in technology utilization in modern life. An understanding of science and technology contributes significantly to the personal, social, professional and cultural lives of everyone (OECD, 2013:98).

The United States gives priority to the education and research sectors to develop STEM (Science, Technology, Engineering, and Mathematics) as a new approach that can be applied in schools to obtain competitive graduates. STEM education leads students to be able to solve problems, inofatif, logical thinking, and insight into technology that qualified. Thus STEM is a very important component of education in the 21st century. STEM education is a crucial issue in the current educational trend. Research shows that the STEM approach will increase students' interest in learning

STEM usually refers to courses related to the disciplines of science, technology, engineering, and mathematics. In the following table 1 will describe STEM lessons in K-12 education, the following:

Table 1. Subject of relevant STEM

Science	Technology
• Biology • Chemistry • Marine biology • Physics • science	• Computer / information systems • Games design • Developer Center • Web Developer / software
Engineering	**Mathematic**
• Industrial Chemical Engineering • Civil Engineering • Computer Engineering • Electrical Engineering • General Engineering • Mechanical Engineering	• Mathematics • Statistics-calculus

(Source: STEM connector in Hannover Research, 2011)

STEM integration can work in scientific investigation and problem solving abilities. This integration is to build a culture of literacy to the community. Literacy STEM refers to the ability of individuals to apply an understanding of the tightness of real-world workplace exchanges.

National Research and Council reveals that science and technology, science, engineering and mathematics learning and assessment have been conducted separately in schools (Harwell, 2015). This has implications for lack of preparation of students collaborating on several disciplines in solving real-world problems. The development of technology and information is currently experiencing rapid growth. Dimensions of the problems facing humans increasingly complex. STEM integration in schools is important because this is for

respond New World of Work in 21st century. Roehrig said that STEM-based learning and assessment are combining discipline of science, technology, technical, and mathematical (Harwell, 2015: 66). This integration aims to: (a) deepening student understanding with contextual concept; (b) expanding student undestanding through social exposure and culture in in the relevant STEM context; and (c) improving of interest in discipline of STEM and student motivation for career in STEM field. Someone who has self confidence in mathematic and science has interesting for a career in STEM field (Milner, 2014:643).

I-Carnegie Global Learning dan Robomatter initiated use a STEM CS for improve education quality in United States. STEM CS is an abbreviation of Sciences, Technology, Engineering, and Mathematics Computer Science. This program is trying to integration of computer science and coding in class with creative and innovative learning, so it makes it fun. Combining learning with coding, students can systematically thinking with computational thinking.

Learners will be guided to solve everyday problems faced in the real world by using technology. From the process of learning to solve this problem is expected to arise new ideas better in solving it. The results of this STEM CS will make learners not only as a connoisseur of technology (consumer) but also the initiator of the technology itself (manufacturer).

In general the use of STEM CS is in line with the formulation of 4 skills that must be possessed by learners in the 21st century NEA idea results, namely:

1. Critical Thinking and Problem Solving;
2. Creativity and Innovation;
3. Communication; and
4. Collaboration.

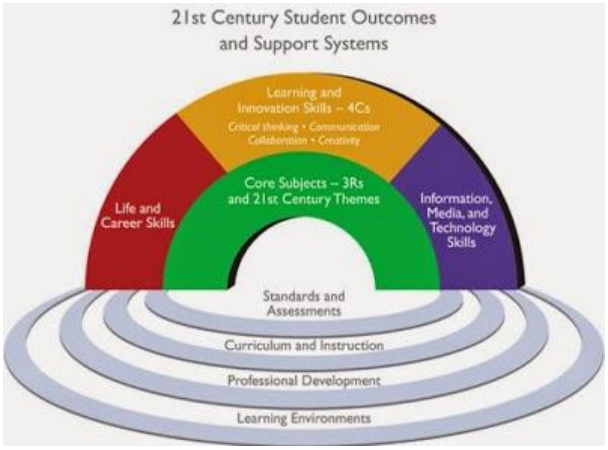

Figure 1. Diagram with the formulation of 4 skills that must be possessed by learners in the 21st century

The Government through Ministy of Education and Culture (Kemendikbud) issued a policy of the Program of Dual System Education (PSG) that is adoption from German with expectations can improving student competence.

Implementation of PSG is organizing Industrial Practice Progam (PI) in every vocational school. Industrial Practice Progam or internship (in SMK) can be an alternative for preparing the quality of human resource to ahead of the ASEAN Econimic Community (Majid & Sudira, 2017). Students are getting technical knowledge and skill in industry to improve insight when they are graduated

from vocational school. In addition, the acquisition of student competencies should be supported by teamwork through industrial practice program (Rochmah & Majid, 2018).

Industrial Practice Program is very effective because students have significantly increased competency. Students are able to demonstrate cognitive, affectve, and psychomotor development which can be described as follows: knowledge about work, work skill, ability to finish of work, and attitude related to DUDI (Abdulmajid, 2016). Thus, SMK must be implemented of STEM based learning, so students have mastery in their fields and compete in work of world.

The result of industry practice is the acquisition of competence for students. The acquisition process of students' competence acquired in the workplace environment. Thus, the process and results of the acquisition of student competencies can be explained through the hierarchy as follows:

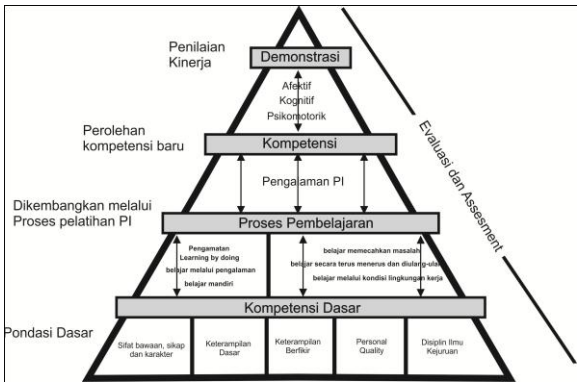

Figure 2. Hierarchy of acquisition process and outcome student competencies (Source: Majid, N.W.A., 2015).

Research questions that should get answers on this research are: How the implementation of STEM education in Integrated SMK PGII Bandung?

RESEARCH METHODS

Types of research

Implemented of STEM education in SMK can be investigated by using qualitative naturalistic method. Case study is more suitable to reveal of some research questions. Case study research is a qualitative study that seeks to find meaning, investigate the process, and gain insight and deep understanding of individuals, groups, or situations (Emzir, 2010: 20).

Setting of Research

This research was located in SMK Unggulan Terpadu PGII Bandung which was at Pahlawan St. 17th Blk, Cihaur Geulis, Cibeunying Kaler, Bandung, Jawa Barat. This Research time implemented during 3 months ie starting from September to December 2017 by way of the researcher first approach the informant, determine the respondent, generate data, analyze the data, and the last is writing a research report.

Data Source

The determination of informants was determined based on the consideration of the research objectives. Selection of this informant intends to reveal the topic given

and expected an informant can master who asked by the researcher.

Informants in this study were: (1) Vice Principal of Curriculum SMK Unggulan Terpadu PGII; and (2) Lecturers of IT / IS.

Techniques and Data Collection

Data collection techniques in this study using 3 ways, namely: (1) in-depth interview; (2) participatory observation; and (3) document analysis. The process of collecting data is done naturally to reveal the implementation of STEM education in SMK.

Data analysis was done in two categories, namely: data analysis during the field to see the learning process in SMK and curriculum study based on STEM education. The model of this research is continuous information digging, so that the resulting data can be met well and to produce saturation data. This data analysis uses an interactive model from Miles, M.B., Huberman, A.M., & Saldaña, J. (2014: 10) as Figure 3.

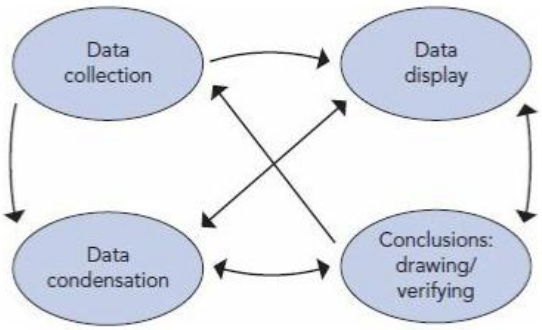

Figure 3. Data analysis components: Interactive Model
(Source: Miles, M.B., Huberman, A.M., & Saldaña, J., 2014: 10)

RESULT AND DISCUSSION

Implementation of STEM in SMK required of student to mastery of competencies who are able to compete in the work of world. The skills of qualified vocational graduates is very important, because competitors in the world of work not only from Indonesia but from abroad. STEM education leads students to be able to solve problems, innovative, logical thinking, and insightful technology.

Curriculum development is undertaken by the Government through the Ministry of Education and Culture (Kemendikbud) to improve the competitiveness of graduates through the competencies required by the market. A curriculum based on a national qualification framework or KKNI requires students to master certain disciplines according to the level of education. Graduates of vocational school will get a predicate expert in their field if able to master the competence in accordance with 2nd level of KKNI.

The 2013 curriculum requires vocational schools to adopt STEM on every lesson. The Curriculum Content of 2013 has STEM that must be mastered by students. This shows the seriousness of the government there is strengthening STEM on every aspect of education. The hope of this application is that students are able to compete at the global level, not only regional or national. Especially free competition is increasingly emerging which indicate the tight competition in the future.

Scientific-based Learning

The implementation of the curriculum of 2013 necessarily requires learning using scientific learning approach. This approach requires students to apply the 5M principle, ie the students must perform the stages of observing, asking, trying, reasoning, and communicating.

Scientific approach is very useful for students, because it can improve the ability of thinking, problem solving, the need for learning is very high, and can communicate scientific ideas. Principles performed on scientific learning include: (1) student centered learning; (2) forming student self-concept; (3) critical thinking; and (4) train student communication.

Students experience significant thinking improvements when critical thinking is applied. Students are able to explore the material well and to develop ideas to apply in different cases. Critical thinking is a very effective method for students to digest in depth material. Whereas in ordinary learning, students just try to remember the material given by the teacher. After that most will disappear by themselves if not recalled.

The idea of the student should be channeled through the interaction between the student and the teacher or the formation of a discussion group, like a forum group discussion, to discuss the particular topic given by the teacher. Students are free to submit their ideas to get common ground in solving the problem. Although the teacher must participate in it so as not to widen or get out of line given problem.

Achievement of Learning Through Sustainable Learning

Achievement of learning in the application of STEM can be seen from the completeness of the material delivered. This can be measured based on students' understanding of the lessons being delivered.

Basically the application of STEM for learning in vocational high schools can't be measured instantly, but it requires a long process of time to see the successful application of STEM education in vocational schools. Outcomes of this learning result is generated ideas or products from students to develop learning materials that have been studied in accordance with scientific capacity or level of knowledge. This idea and / or product is expected to contribute to meeting the needs of the people in Indonesia in accordance with the field of study. Achievement of STEM implementation is expected to graduate: (1) expanding the number of students skilled in the field and career; (2) able to work in the world of work; and (3) improving literacy skills in all students (National Research Council, 2011).

Thus, the expectation of achievement of KKNI level in SMK graduates can be fulfilled if the application of STEM learning goes well. STEM has characteristics by integrating science, technology, engineering, and mathematics in solving a real problem faced. Usually practice engineer / engineering

studies program tries to integrate STEM into a subject, although in Indonesia it is very difficult to integrate STEM into a subject. Deeper integration into the form of transdisciplinary subjects requires comprehensive restructuring of the curriculum, making it relatively difficult to implement in the context of the conventional curriculum structure in Indonesia (Rustaman, N., 2016:10). Although in its development can be done gradually.

STEM-based curriculum requires a balanced blend of science, technology, engineering, and mathematics. These four components become a united one to produce scientific thinking, think mathematically and be able to engineer a technology to be appropriate for society. This capability should be owned by vocational education graduates, especially vocational students. In vocational schools the average has already implemented STEM, since the curriculum used has been designed to implement STEM. The expectation of such implementation is so that students can master and have ability in accordance with KKNI based on STEM based approach.

CONCLUSION

STEM-based learning is part of the fulfillment of SMK education goals. STEM education leads students to be able to solve problems, innovative, logical thinking, and insightful technology. So STEM will be implemented if: (1) scientific -based learning; and (2) achievement through sustainable of learning.

Principles performed on scientific learning include: (1) student centered learning; (2) forming student self-concept; (3) critical thinking; and (4) train student communication.

STEM has characteristics by integrating science, technology, engineering, and mathematics in solving a real problem faced. This capability should be owned by vocational education graduates, as well as requiring no short time. Therefore STEM learning requires continuous development. The purpose of the application is to enable students to master and have the ability in accordance with the KKNI based on the STEM-based approach.

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