Development of Standard Operational Procedure (SOP) for the implementation of lathe machining practice in Vocational High School (SMK)

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Abstract. The objective of this research is to first get Standard Operational Procedure (SOP) of machining technique in Vocational High School (SMK), to get standard of tool, to get standard of time and standard amount of material for practicum of lathe machining technique in SMK to reach competent flat, facing, tapered lathe, lathe turning, screw lathe and lathe cartel. This research uses ADDIE (Analysis, Design, Development, Implementation and Evaluation). Participants of this study involve students and teachers from one public vocational school and one private SMK who both have accreditation A. SOP obtained consists of rational, objectives, competencies and procedures (work drawings, work flow, practice worksheets, job sheet, assessment sheet). Practical tools for flat turning competencies, face turning and tapered turning with lotan work drawings need 1 main tool, 1 cutting tool, 2 tools, 1 measuring tool, and 4 K3LH tools, while the lathe competence, screw lathe and lathe cartel with picture mandrel work requires 1 main tool, 4 cutting tools, 5 tools, 1 measuring instrument, and 4 K3LH tools. The standard practicum time to achieve flat turning competence, face turning and tapered lathe is 2x experiment is 423 minutes, while standard practicum time for achieving line plowing competence, screw lathe and lathe cartel with 2x experiment is 372 minutes. The practicum material used is st37 for a lottery image of ø25.4 x 105 mm in size requiring an average of two workpieces and a mandrel image requiring materials of ø25.4 x 65 mm in size which averages require two workpieces for each student.

1. Introduction
The industry utilizes high technology to improve its production, hence the need for skilled and competent workers [1,2,3]. Competence is generally defined as a combination of the knowledge, skills, abilities and other characteristics required to perform tasks in a particular job [4]. To become a worker with standard competence requires skill and practical skills in a certain field called vocational competence [5].

Vocational Education is education that combines formal education with experience in the workplace [6]. The purpose of vocational education is to produce graduates who have the competence to perform certain jobs effectively [7]. In addition, vocational education graduates are expected to be semi-professional workers who are expected to be ready to work and have reflexes to adapt to work assignments in the workplace [8]. In the process of vocational education provides practical engineering and practical skills based on professional knowledge of a particular field [9].
Vocational High School (SMK) is one of the innovations and levels of vocational education. SMK is an education that prepares its graduates to enter employment and develop professional attitude [10]. There are problems based on observation research condition of readiness of students is still relatively low, that is 35% who states ready to work with the provision of knowledge obtained during the vocational school [11]. The readiness of SMK graduate work is influenced by the factors of science, skill, and attitude gained in learning [12]. SMK integrates theory and practice in every stage that means theoretical education supported by training directly on the learning process [13].

Practical learning is the hallmark of SMK [14]. Practical learning is a learning process whereby learners engage and experience themselves, following the process of the material they have learned, thus developing all the affective, cognitive and psychomotor potential of the student. Practicum is perfect for training education, as it is useful for training the required skills. Practicum activities in vocational schools are carried out in a guided manner.

Practical tools are one of the main things to support learning. The ratio of the number of tools and students should be appropriate. As for the Single Work Station group tool type (WST), the ratio of the number of tools and the number of students should be 1:1 [15]. The results one of research concluded that the tool in one of the SMKs has a ratio between the number of machines including the WST with the number of students away from the standard ratio and in line with those results [16], the author's initial observation in one of the SMKs found the ratio of the number of machines and the number of students was 1:9, whereas the learning needs to use facilities and infrastructure along with the real situation in accordance with the industrial world [17].

Minimum Service Standards (SPM) of SMK that is 90 percent have minimal facilities and infrastructure in accordance with national standards established [18], but the minister's regulation on the standard of facilities and infrastructure of SMK for engineering majors has not set standards number of tools and materials therein [19], whereas tools and materials are the main factors of technical implementation of the lab. Based on this, documentation is needed to guide the availability of tools and materials for the implementation of the practice.

The result of observation and interview with one of the vocational teachers in the lathe, the allocation of time for one lesson year is 324 hours (45 minutes real time / one lesson) / 36 meeting (9 hours lesson / meeting) with the division for 30% (97 hours of lessons) and 70% of the lessons (227 lessons) are often missed, because they are tailored to the school's academic calendar with effective number of effective days each year. The allocation has not specified the time and number of exercises to achieve per competency, so that the time and number of practical learning meetings to achieve certain competencies is determined by the qualifying teacher requiring the student to follow the teacher's requirements and sometimes without regard to student's aptitudes on practical learning resulting in a lack of time [20,21,22]. This is because there is no fixed reference for the amount of training and time allocation for the achievement of lathe machining competencies, especially considering the ratio of the tool to the ratio of learners, because the availability of each tool of different SMKs that allows the achievement of different competencies.

This study aims to develop Standard Operating Procedures (SOP) regarding time allocation, the number of tools and the amount of consumables needed to achieve certain competencies in the practice of lathe machining techniques. SOP is a guide or reference in the form of documents containing detailed instruction and detailed protocol regarding executor, time, tools and materials [23,24,25,26]. The result of this research is expected to be a SOP for the implementation of Practical Learning Machining Techniques in order to run effectively and efficiently in terms of time allocation, tools and materials.

2. Method

This study aims to produce Standard Operating Procedures (SOPs) that encompass process standards, time standards, tool standards and standard quantities of materials. This research procedure refers to the development stage of the ADDIE model. Stages in the ADDIE model include Analysis, Design, Development, Implementation and Evaluation. Stages of this research can be seen in the picture below:
In general, Figure above can be explained as follows:

1) Stage Analysis
   The first stage in this study consists of:
   a. Needs Analysis
      Identification of problems and needs of Operational Standard Implementation Procedures for
      Machine Tool Practice at SMK
   b. Interviews with subject teachers.
      Identify existing problems in learning activities and needs Operational Standard Implementation
      Procedures Machine Tooling Practice at SMK.

2) Design Phase
   This development design is a standard operating procedure (SOP) practice of lathe machining
   technique. Steps of making the product starts from determining the format of SOP, determine the
   competence and determine the work drawings based on the competencies specified.

3) Development Phase
   At the development stage is to realize the standard operating procedure design (SOP) is made. At
   this stage SOP design is also done by expert validation (judgment expert) and allows revision based
   on expert input before it is tested in the field. The steps of SOP development as follows:
   a. Make SOPs based on the specified format.
   b. Create a predefined work image.
   c. Creating Jobsheet based on working drawings.
   d. Judgment expert.

4) Implementation Phase
   Product trials are conducted on the implementation of the students' lathe practicum technique which
   has not mastered the flat-bending competence, turning the face, tapered, plowing, turning the screw
   and turning the cartel to see the flaws and getting standard time, standard tools and standard amount
   of material required.

5) Evaluation phase
   Evaluation is the step performed in the ADDIE model. This stage is carried out at every step of the
   analysis, design, develop and implementation to get effective and efficient SOP as needed.
   Participants in this study were students of engineering department of class X who studied subjects of
   mechanical technology and XI who studied the lathe of machining techniques and teachers directly
   involved in the implementation of machining engineering practice. The place or location of this research
   is carried out in two vocational high schools that have engineering majors.

3. Findings and Discussion
   Standard Operating Procedures (SOPs) consist of rational, objectives, competencies and procedures.
   Rational is a description of the practicum, the objective is the objective of the SOP, the competence is a
   series of competencies to be achieved after carrying out the practice of lathe machining techniques and
   procedures that include the prerequisites of practicum technique of lathe machining, the process of
   practicum implementation, the practicum time and the necessary tools and materials.
   Equipment for lotan work is lathe (main tool), flat chisel tool (cutting tool), chuck lock (tool),
   toolpost lock (tool aid), 150 mm duration tilt 0.02 mm (gauge), work clothes (Occupational Safety and
Health and the Environment (K3LH), work shoe (K3LH), glasses (K3LH) and hair band (K3LH). Tool for mandrel work is Lathes (main tool), flat chisel (cutting tool), drill (drill), cartel (cutting tool), screw threads (metric tool), chuck lock, toolpost tool, flashlight (tool), chuck drill 150 mm ketiluan 0.02 mm (measuring instrument), work clothes (K3LH), work shoes (K3LH), glasses (K3LH) and hair band (K3LH). These tools are a tool that must be available with a comparison of tools and students is 1:1 for the practicum to run effectively and efficiently (Supriyatna, 2016).

The average practicum time gained for achieving flat-turning competence, face turning and tapered lathe with lotan drawings was by two trials, in which the first experiment was two hundred and thirty-four minutes and the second experiment was one hundred and eighty-nine minutes so the total time required is four hundred and twenty-three minutes. The average practicum time gained for achieving a plane lathe competence, turning the thread and placing the cartel with mandrel working drawings is by two trials, in which the first experiments are two hundred and five minutes and the second experiment is one hundred and sixty seven minutes so the total time required is three hundred and seventy-two minutes.

The average lotan working image of the first trial value is forty nine point three and eight and the second experiment is eighty five point six three. The Minimum Criterion of School is seventy-five so students can be said to have achieved competence because the second average score exceeds the KKM and the practice to achieve flat turning competence, face-bolting and tapered lathe are two exercises which mean two pieces of workpiece. The average mandrel working image of the first experimental value is fifty-seven point two five and the second experiment is eighty-eight point six. Students can be said to have achieved competence because the second average score exceeds the KKM and the exercise to achieve the lathe competence, turning the screw and lathe cartel are two exercises that mean two pieces of workpiece.

4. Conclusion
SOP obtained consist of rational, purpose, competence and procedure (drawing work, workflow, work practice, job sheet, assessment sheet). Practical tools for flat turning competencies, face turning and tapered turning with lotan work drawings need 1 main tool, 1 cutting tool, 2 tools, 1 measuring tool, and 4 K3LH tools, while the lathe competence, screw lathe and lathe cartel with picture mandrel work requires 1 main tool, 4 cutting tools, 5 tools, 1 measuring instrument, and 4 K3LH tools. The standard practicum time to achieve flat turning competence, face turning and tapered lathe is 2x experiment is 423 minutes, while standard practicum time for achieving line plowing competence, screw lathe and lathe cartel with 2x experiment is 372 minutes. The practicum material used is st37 for a lottery image of ø25.4 x 105 mm in size requiring an average of two workpieces and a mandrel image requiring materials of ø25.4 x 65 mm in size which averages require two workpieces for each student.

References
[1] Schlingensiepen, J. 2013. Competence Driven Methodology for Curriculum Development Based on Requirement Engineering. Selection and peer-review under responsibility of the Organizing Committee of WCLTA 2013. Procedia - Social and Behavioral Sciences 141 (2014) 1203 – 1207 Technische Hochschule Ingolstadt, Esplanade 10, 85019 Ingolstadt, Germany.
[2] Nuryake, F. 2012. Evaluasi Pelaksanaan Teaching Factory SMK di Surakarta. Jurnal Pendidikan Vokasi, Vol 2, Nomor 3, November 2012.
[3] Paulson, K. dkk. 2005. Learning at Work: Competence Development or Competence-Stress. Applied Ergonomics 36 (2005) 135–144.
[4] Uhm, M. dkk. 2017. an Analysis of BIM Jobs and Competencies Based on the Use of Terms in the Industry. Automation in Construction 81 (2017) 67–98
[5] Sukmadinata, N S & Syaodih, E. 2012. Kurikulum dan Pembelajaran Kompetensi. Bandung: Refika Aditama.
[6] Rahman, A. dkk. 2013. Assessment Practices for Competency Based Education and Training in
Vocational College, Malaysia. *International Conference on Education & Educational Psychology 2013 (ICCEPSY 2013)*.

[7] Oviawe, J.I. dkk. 2017. Bridging Skill Gap to Meet Technical, Vocational Education and Training School-Workplace Collaboration in the 21st Century. *International Journal of Vocational Education and Training Research 2017; 3(1): 7-14 Department of Vocational and Technical Education, Faculty of Education, Ambrose Alli University, Ekpoma, Nigeria*.

[8] Hadi, M.Y.A. dkk. 2015. Application of Thinking Skills in Career: A Survey on Technical and Vocational Education Training (TVET) qualification semi professional job duties. *2nd Global Conference on Business and Social Science-2015, GCBSS-2015*. Indonesia: Bali.

[9] Wang, T. (2010). Educational benefits of multimedia skills training. *TechTrends, 54(1), 47–57*.

[10] Keputusan Menteri Pendidikan dan Kebudayaan Republik Indonesia Nomor 0490/1992 Tentang SMK.

[11] Afriani, R. & Setiyan, R. 2015. Pengaruh Persepsi Siswa Tentang Kompetensi Kejuruan, Penguasaan Soft Skill, dan Kematangan Karir terhadap Kesiapan Kerja Siswa Kelas Xii Akuntansi SMK Negeri 2 Magelang Tahun Ajaran 2014/2015. Semarang: *Economic Education Analysis Journal 4 (2) (2015)*.

[12] Gunawan, A.H. 2000. Sosiologi Pendidikan. Jakarta: Rineka Cipta.

[13] Emir, O. 2013. The Effect of Training on Vocational High School Students in Their Professional Development. *4th International Conference on New Horizons in Education*.

[14] Mariah, S. 2012. *Model Pengembangan Soft Skills dalam Pembelajaran Praktik Untuk Kesiapan Kerja Siswa SMK Bidang Keahlian Tata Busana di Industry Garmen*. (Disertasi). Sekolah Pascasarjana, Universitas Pendidikan Indonesia, Bandung.

[15] Supriyatna, Y. 2016. *Strategi dan Inovasi Pendidikan Kejuruan*. Bandung: Alfabeta.

[16] Bukit, M. (2014). *Estimasi Waktu dan Biaya untuk Menguasai Keterampilan Psikomotor Siswa pada Mata Pelajaran Melakukan Pekerjaan dengan Mesin Bubut*. (Tesis). Sekolah Pascasarjana, Universitas Pendidikan Indonesia, Bandung.