F.3 Technical working skills of vocational high school students at the interface between digital workplaces and school. An empirical study about construction engineering drawings in Indonesia.

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Abstract: Recent studies report about the need for and difficulties in measuring technical working skills among vocational high school students worldwide (Mabed & Köhler, 2018). Often the discussion is linked to the question of skills versus competencies, not only in the context of new digitized forms of measurement. Furthermore, a growing number of completely new or updated measurement procedures is about to reach the TVET sector in the context of the digitization of TEL (Köhler & Drummer, 2018; Hariyanto & Köhler, 2017). This study aimed at investigating the differences of the technical skills of vocational high school students majoring in construction drawings engineering in industrial working practices. As an empirical approach for their evaluation study authors used a discrepancy evaluation model. The population of this study consisted of 195 students in Yogyakarta and Sleman, Indonesia. A proportional random sampling was used to select 124 students from the population with both, the industrial work and the students becoming the sources of the information. The data analysis process was done using descriptive analysis and Wilcoxon matched pairs test analysis to describe and find the gap/discrepancy of students' technical skills based on the predetermined standard.

The results of the study show that the technical skills of vocational high school students in their industrial working practices are categorized as good with a low discrepancy based on the industrial assessment, and even better based on the students' self-assessment. Yet there is a significant difference of technical skills among the vocational high school students in their industrial working practices based on the industrial work and students' assessment with a significant value of 0.000 < 0,05.

1 Introduction

1.1 Legal and professional conditions

Oleynikova (2009) states that technical and soft skills become very important things for an individual to be employable. Technical skills enable someone to plan and work effectively on a project. "Technical skill is knowledge about and proficiency in a specific type of work or activity. It includes competencies in a specialized area, analytical ability, and the ability to use appropriate tools and technique" (Northouse, 2013, p.44). Technical skills are knowledge and competences related to types of jobs or certain activities which include specific competence, analytical competence, and the competence of using some equipment in appropriate ways. Farkas & Nagi (2008) point out that "…graduates need technical skills to be successful at work can be called as quantitative attributes which tend to deal more with technology or discipline based knowledge." The graduates need technical skills in order to succeed in workplaces or called as a quantitative attribute which is related to technology and knowledge with discipline basis. Marquet & Köhler (2018) as well Köhler & Drummer (2018) describe how such demands arise from an ongoing digitization of both the work place and as well the vocational classroom.

Technical skills which are needed by students varied based on their study programs. For example according to the Regulation of the Minister of National Education of the Republic of Indonesia No. 28 Year 2009 about basic competences of vocational high schools. The technical skills are given to the students as a part of the competencies students must master in order to be able to perform well in a job. If an individual already has a competence and then he/she is given a certain job and tasks in accordance with his competence, he/she will be able to perform work according to the volume and dimensions specified, quality based on the standard and specification, and can complete it within the required time (Degree of Minister of Labor and Transmigration of the Republic of Indonesia No. Kep.327/Men/IX/2009).

Skills of construction drawing engineering are a part of the work fields prepared through vocational high school education. This expertise package is organized to prepare well-trained personnel in some specific positions. The position for the construction drawing engineering is an Architecture Draughtsman. In the construction works, an architectural drawer is responsible to carry out drawing tasks to be used for the designing process/documentation/implementation techniques based on the architect's technical specifications.

Thomas (1990, pp.1–2) notes some stages which need to be understood in order to be able to make a drawing plan. They are: (1) initial design: making a sketch of drawing

by considering the appropriateness, aesthetics, and budget; (2) approval: needing an approval from the individual, society, company, government, or the local authority, because the size and scope of the civil engineering project is big and can affect the environment and society; (3) details design: taking into account the time and resources which are needed to prepare detail drawing; (4) contract document: making work plan and the requirements, budget plan, technical specifications containing the type of the materials and the prices, so that they can give information to the contractor in order for them to be able to do their job in building the constructions based on the drawing plan and technical specifications; (5) constructions: building constructions, in this case, the contractor is responsible for finishing the building based on the design and work safety; and (6) information and advertisement: in the construction industry, a drawing which has a high quality is done using AutoCAD which is a drawing software having high accuracy (Francisco, 2000, p.2). Architects, engineers and contractors are using AutoCAD to visualize the constructions in the form of 2D Figural drawing.

1.2 Educational and technical approaches

The Japanese researcher Higuchi (2015; pg. 106) explains how the application of the Idea-Marathon Principle may be used for ignition and fostering creativity among pre-school children and describes that "many efforts have been given to develop their creativity through free drawings, playing with clay and any other crafting, though they have not been developed well in their linguistic ability. Moreover, he suggests a two-step method for these preschoolers which consist first of a daily sketching of small objects in front of the children by using pencils on a small piece of paper and later on to trigger the children thinking when transferring the drawing and writing into creating ideas and studying by respective questioning, Obviously, drawing has a strong meaning for developing creative thinking skills. In the other hand, the competence of drawing using software is needed by students in order to be able to do their industrial working practices well and support their future career. Some drawing software for designing a building which is suitable with the development of the industrial world are AutoCAD, Google Sketch Up, and V-ray. AutoCAD is a drawing software which is used to make drawings in the form of 2D and 3D.

Morrison (1996, pp.11–13) explains that some technical basic competences to draw using AutoCAD are: (1) the ability to create (create); (2) the ability to edit (edit); (3) the ability to manipulate (manipulate); and (4) the ability to measure (dimensioning) which is to make some information or explanations about the size of drawing design planning appropriately using dimension instructions (dimension). Grover (2009, pp.1-2) defines Google Sketch Up as a drawing software which is used to make drawings in 3D form. Sketch Up is usually used to visualize artwork of 3D buildings or constructions, interior and exterior design, furniture, landscape of buildings and

things in daily life. Tal (2009, p.11) explains that in order to be effective in using Sketch Up in the process of modelling, people should have a good understanding about Sketch Up basic concepts, including understanding the functions of some tools in it.

Again Grover (2009, pp.22–23) lists competences in applying the software (Sketch Up) which are presented as follows: (1) making new documents for working by setting the view and template of the screen based on the design needs; (2) drawing using drawing instructions; (3) improving and changing the drawing objects using modified instructions or adding texts; (4) organizing the layering techniques to manage the complicated planning drawings; (5) using grouping techniques or components in drawing 3D objects; (6) changing the view style and applying materials to make the view or appearance more realistic on the drawing objects; (7) saving the view and animations using scenes; and (8) saving, printing and dividing the drawing files.

Thiriet (2011, p.12) postulates that when drawing interior designs, the details on the drawing models or textures such as stone walls, wooden floor, and concrete as walls need to be considered in order to create realistic drawings. The use of appropriate textures also affects the drawing quality. There are several textures provided in Google Sketch Up which can be integrated with drawing design using tools, namely paint bucket tool & the colors palette. In line with Tal (2009, p.55) who describes that the use of textures and colors can make the meaning and design surface stronger. Thiriet (2011) further states that adding textures which match the needs can be done using finishing touch to create drawings with a good render quality. Finishing touch is a neon luminaire intensity setting in the ceilings or direct sunshine. It can also be done by placing some human pictures to models as the 3D objects, trees and bushes to get appropriate shadow effects with the right geofigureal location, time and dates. In the end, the 3D drawing design using a software which is Google Sketch Up should be able to efficiently convey the essence of a building to the customers. In addition to that, Playford (2011, p.44) explains that drawing design using SketchUp can be easily explored, so it can illustrate the drawings and models more in creating clearer and more realistic drawings.

As adequate technical skills are needed in every work area or industry, knowing or understanding the technical skills indicators is very important for vocational high school students. Observation and assessment of students' technical skills in their industrial working practices have some indicators as follows: (1) implementing work of drawing for planning/documentation/technical process based on the technical specifications/architect's guidance; (2) drawing using software; and (3) reading shop

drawing. However: to what extent does the software based technical skills of the vocational high school students match the needs (their competency) to be applied during their industrial working practice?

2 Research question and Methods

In order to address this research question, a field research is designed as an evaluation study by using a qualitative approach and survey, adopting the discrepancy evaluation model by Provus (1969). It serves as conceptual basis and to measure the gap or the discrepancy between the technical skills of the vocational high school students in their industrial working practices which was achieved or the real condition in the field where they did some jobs in the industrial context with standards which have been set based on relevant theoretical review and the industrial needs. This research was conducted for four months from August to December 2016 in some locations as industrial partners of the vocational high schools in Yogyakarta and Sleman, both in Indonesia, where the students majoring in construction drawing engineering did their industrial working practices.

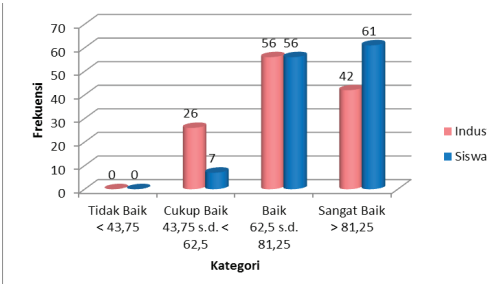
The research population consisted of 192 students where form the sample of 124 students was selected by using proportional random sampling.

The data analysis technique employed in this research was descriptive analysis, and Wilcoxon matched pairs test analysis. Descriptive analysis was used to portray the scores of students' technical skills using the criteria. Wilcoxon matched pairs test analysis was used to find out whether there was a gap or discrepancy between the technical skills standards which have been determined and the students' technical skills which are achieved in their industrial working practices. It was also employed to know the score of the discrepancy is by categorizing the discrepancy level and the criteria which have been determined. The technical skills assessment criteria were divided into four groups (Hadi, 2004, p.126), the group is Students' Performance Criteria which are presented in four description level; Very good, Good, Fair, and Not good.

Added to that, the criteria used to categorize the discrepancy level based on Suryantari & Sumantri (2016, p.62) are presented in five discrepancy level ; None, Very low, Low, High enough, High, Very high.

3 Results and Discussion

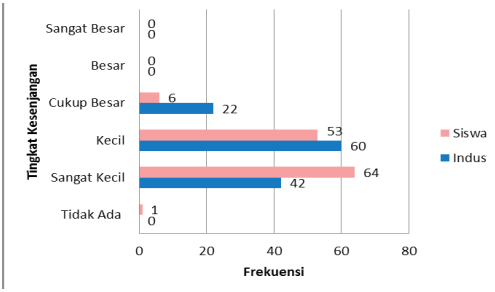
According to the result of descriptive analysis, the average score (mean) of the technical skills of vocational high school students majoring in construction drawing engineering in their industrial working practices in Yogyakarta and Sleman was 73.34 out of 100 based on the students' self-assessment (in intervals of 62.5 to 81.25 categorized as **Good**.



Sangat Baik= **Very Good**; Baik= **Good**; Cukup Baik= **Fair**; Tidak Baik= **Not Good**

Figure 1. Technical skills Distribution of Vocational High School Students in their Industrial Working Practices based on the Industrial Assessment and Students' Self-Assessment

The result of Wilcoxon matched pairs test analysis showed that there was a discrepancy in the technical skills of vocational high school students majoring in constructions drawing competence engineering in their industrial working practices based on industrial or students' assessments using the determined standard. The discrepancy level of students' technical skills based on the industrial assessment was 26.66% and 20.42% based on the students' assessment and categorized as low. The discrepancy was in all the indicators of the students' technical skills in the industrial working practices.



Discrepancy Level: Sangat Besar=**Very High**; Besar=**High**; Cukup Besar=**High Enough**; Kecil=**Low**; Sangat Kecil=**Very Low**; Tidak ada=**None**

Figure 2. The Frequency Distribution of the Discrepancy Level of Students Technical skills in Their Industrial Working Practice Based on Industrial Assessment and Students' Self-Assessment

In the industrial working practices, students were able to implement drawing for planning process and the specifications based on the standard of drawing and technical specifications related to new materials in the real workplace. In using software, students have mastered AutoCAD and Google Sketch Up as the technology helping and supporting the design of constructions. In the implementation at the real workplace, students were able to interpret drawings appropriately so that it could be implemented matching with the design. However, they still need to have more practices and assignments in drawing with details and in drawing 3D objects, including grouping objects (components/groups), lighting, view, scene and V-ray rendering process (setting/material/object lighting/layout).

Vocational education syllabi confirm that an engineer should have technical skills as a self-attribute related to technology, specific competence, analytical skill, the competence of using tools and suitable yet appropriate techniques which continuously need renewal (Nabeel et al., 2015). Students with decent technical skills are able to perform well and effectively in the field of expertise, because with the technical skills, students are able to understand how to finish the job given to them. Therefore, the sufficient skills will help them to be able to create good quality drawings. It is in line with a theory from Oleynikova (2009) stating that technical and soft skills are important parts for individuals to be employable in the workplace. Obviously in the field of technical drawing a large change began with shift from pencil based drawing to CAD in the 1990s. Due to that it became even more clear that (information) technical skills enable individuals to arrange and design plans and work effectively in certain projects. Therefore, technical skills are needed as the parameter of the students' quality in their industrial working practices which plays an important part in order to succeed in the work area.

This study showed that students had different technical skills qualities based on the knowledge, the competence and the experience which has been learned at school in finishing every job given by the industry during the industrial working practices. It also showed that the schools having good learning environment completed with proper facilities and technology would result technical skills which were relevant to the needs in the industry. Therefore, students in their industrial working practices could develop their potentials to get experiences and particular competences to be successful in the future. In line with Prosser's principle saying that vocational education should be very responsive and anticipative with the development of technology, especially the development of drawing software in line with constructions industries.

4 Conclusions and Suggestions

4.1 Conclusions

Based on the industrial assessment and students' self-assessment, the technical skills of vocational high school students majoring in constructions drawing engineering in their industrial working practices were categorized as good.

The discrepancy in all indicators of technical skills, namely drawing for planning process, drawing using software and reading shop drawing was in a low discrepancy level of 26.66% and 20.42%.

There was a significant difference in technical skills among vocational high school students majoring in constructions drawing competence engineering in their industrial working practices in Yogyakarta and Sleman based on the industrial with the significance of 0,000 < 0.05. Meanwhile, based on the result of test of between subjects' effects, it was shown that the students' technical skills had significant differences in all indicators.

4.2 Suggestions

In particular, the technical skills of vocational high school students majoring in construction drawing engineering in their industrial working practices based on the industrial and students' assessment are in a good category with a low discrepancy level. However, the students still need to learn many things and evaluate themselves, such as: (1) In drawing 3D design, the students need to be able to create and add it in the scene, so that in presenting the design drawing, they can show the view of the construction in detail. They also need to get accustomed to organize every drawing element using layering techniques and implementing grouping techniques or components in 3D object design in a more effective way.

Besides, they need to improve their ability in mastering lighting, shadow, reflection and refraction techniques, so that they will get drawing design with strong or smooth visual effects in a high quality and realistic. In drawing 2D object, the students need to practice minimizing drawing file size in AutoCAD; and (2) the students need to practice and discuss with the architect to get some advice related to the time allocation needed in finishing the drawing efficiently and properly.

Furthermore, more tasks and jobs representing a profession as an engineer should be given for students during their industrial working practices. Having many working experiences can help the students succeed in their future careers. Hence,

the government needs to re-examine things related to curriculum standards in the implementation of industrial working practices and set the best time to do that in order to achieve the goals based on the quality standard.

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