The abilities of vocational high school students in reading of orthogonal projection drawing

J Puspito, Y P Putra, D Kurniawan and B R Setiadi
Department of Mechanical Engineering Education, Universitas Negeri Yogyakarta, Indonesia

E-mail: jarwopuspito@uny.ac.id

This study aims to determine the ability to read orthogonal projection images of Seyegan VHS students. This research is an ex post facto research. This study's population was all XI classes of Fabrication and Metal Manufacturing Engineering, as many as 51 students. The research sample was 44 students based on calculating the 5% error formula by selecting by simple random sampling—collecting data through a test, which consists of 42 questions. The validity test uses the product-moment correlation, and the reliability test uses Alpha Cronbach. Data analysis using descriptive statistical analysis techniques. The results showed that the students' ability to read orthogonal projection drawings in the very good category was 56.8%, the good category was 11.4%, the moderate category was 20.4%, the bad category was 9.1% b, and the very bad category by 2.3%. In general, the score shows that the VHS state of Seyegan students is in the very good category.

1. Introduction
Vocational High School or abbreviated as VHS, is one of the secondary education levels with the specialty of preparing graduates to be ready for work [1]. The vocational education developed in Indonesia is designed to prepare students as graduates ready to enter the world of work and develop professional attitudes in the vocational field [2]. These graduates are created to be productive individuals who can work as a medium-sized workforce and have the readiness to face competition in the world of work [3].

The VHS portrait raised in this case study is the VHS State of Seyegan. This school has made various kinds of academic achievements at local and national levels—one of the subjects given in the VHS State of Seyegan to students in the Engineering Drawing subject. Engineering Drawing Lessons is one of the subjects contained in the Metal Fabrication and Manufacturing Engineering study program. Based on preliminary observations, learning engineering drawings is carried out in the same classroom as classrooms that are usually used for other lessons. Students tend to be less active in participating in lessons, actively use smartphones, and lack teacher attention to providing quality academic services. This is the same as the research in Indonesia with cases about learning engineering drawings [4]–[6]. Students' material in technical drawing subjects included the introduction of the rules for completing technical drawing information, geometric construction drawings and recognition, and presentation of the types of projection images, among these subjects that were found difficult by students, namely projection image material.

Theoretically, the need for technical drawings for VHS graduates is critical as capital for fundamentally developing other supporting skills [7] such as fabrication and manufacturing. The
technical drawing function is a medium for expressing one's goals [8]. Therefore, technical drawing is known as the language of technical people. Inside the engineering, drawing has many rules that the VHS state of Seyegan students must learn. One of the topics often referred to and needed in work is projected images. A projection image is a way of depicting a point, object, line, plane, object or an object's view of an drawing plane [9]. The design transformation that is often implemented in learning is an orthogonal projection. This orthogonal projection can be displayed in two dimensions with several views [10].

The challenge of technical drawing is how students can read design drawings with various forms and presentation [11]. The ability to read technical drawings is the ability that a person has in interpreting or translating ideas and signs of work in the form of images to understand the intent and commands in the technical drawing. This research is urgent to do because the ability to read orthogonal images must be mastered by students so that during practicum activities in the workshop, or in the world of work, they will understand and understand assignments or job sheets in the form of work drawings given by them [12]. The ability to read orthogonal images can improve students' ability to interpret and understand images in a 2-dimensional presentation. However, this research is the first step in the progress of research in exploring students' ability to read orthogonal projection images and impact the ease with which other projections.

2. Method
This research uses ex post facto with a quantitative approach. A quantitative approach is defined so that all symptoms can be observed in numbers and statistical analysis [13]. To support the research method, a research procedure was prepared. The study population was the VHS state of Seyegan students in class XI TFLM 1, amounting to 25 students and class XI TFLM 2 totalling 26 students. Suppose both of them a total of 51 students. The sample used is a simple random sampling technique, based on Issac and Michael's formula with an error level of 5% and a confidence level of 95%. It can be seen that the sample size that must be taken is 44 people.

The data collection technique is the test method. The test in this research is a series of questions that students must answer to measure the ability to read students' orthogonal project images. The form of the test used was a written test with a multiple-choice model and a true-false test with 42 question numbers. The instruments arranged aim to obtain information from respondents about the ability to read orthogonal projection images. The criterion for the score or score in this test is that each correct answer gets a score of one, and the wrong answer gets a score of zero.

The data analysis technique used descriptive analysis. Descriptive analysis is presented by calculating the maximum value, minimum value, mean (M), median (Me), and mode (Mo). Descriptive analysis in this study using the help of SPSS 25 for Windows software. Analysis to measure the ability to read orthogonal projection images uses data trend values with limitations including very good, good, moderate, bad, and very bad categories.

3. Results and Discussions
The study results regarding the ability to read orthogonal projection drawings in the VHS state of Seyegan students were in the very good category. This is because the number of research samples who answered most was included in the very good category, 56.8%, and 25 students. The data trend value for the ability to read orthogonal projection images can be seen in Table 1.

| Statistic               | Results |
|-------------------------|---------|
| Lowest score            | 8       |
| Highest score           | 41      |
| Average score (Mean)    | 29.32   |
| Middle score (Median)   | 32      |
| Frequent score (Mode)   | 33      |
After the descriptive analysis results are obtained, the next analysis process is to identify the data trend on the ability to read orthogonal projection drawings. As seen in Table 2, the students’ ability to read orthogonal projections which were in the very bad category amounted to 1 student (2.3%); bad category amounted to 4 students (9.1%); medium category amounted to 9 students (20.4%); good category amounted to 5 students (11.4%), and very good category amounted to 25 students (56.8%). The student's ability to read orthogonal projection images is in the very good category.

Table 2. The tendency to read orthogonal projection drawings

| Interval          | F  | Categories | (%)   |
|-------------------|----|------------|-------|
| X ≥ 31,5          | 25 | Very good  | 56.8% |
| 24.5 ≤ X < 31.5   | 5  | Good       | 11.4% |
| 17.5 ≤ X < 24.5   | 9  | Enough     | 20.4% |
| 10.5 ≤ X < 17.5   | 4  | Bad        | 9.1%  |
| X < 10.5          | 1  | Very bad   | 2.3%  |

To distinguish the abilities of students capable and less able to achieve minimum completeness can be proven by conducting tests. The results of the test answers that answered correctly were 75% of the 42 questions tested. Students who can read projected images have 25 students, and students who are less able to read technical drawings are 19 students—based on the test instrument, the ability to read orthogonal projection images distributed in several questions. Problem numbers 1-17 students are asked to choose the front view, right view, and view of an image from a European projection, then questions number 18-28 students are asked to choose an orthogonal projection in the American system from some of the pictures provided, then question number 29-33 students were asked to determine whether the orthogonal view was right or wrong in the European system. In questions, 34-38 students were asked to choose a picture from an orthogonal view of the European system, and questions 39-42 were asked to choose an orthogonal view of the European and American system from some specified images.

This research's findings are that students with poor grades are due to lack of understanding of questions about determining orthogonal views both front, top, and right with the European system, determining the American projection, and determining the right or wrong of an orthogonal projection. Students with relatively weak ratings determine actual or false orthogonal projections and determine the image's American projection. Students in the good category, even though many understand the given questions, those who get this score can determine orthogonal views both front, top, and right of the European system and determine the American projection. Students with very good assessments found that few students did not understand the material about determining the American projection from a predetermined image and determining a projection's right or wrong.

4. Conclusion
The conclusions obtained from the synthesis process showed that the students' ability to understand and read projected images was in the very good category of 56.8%, amounting to 25 students, the good category of 11.4% totaled five students, the moderate category of 20.4% amounted to 9 students, the bad category was 9.1% for four students, and the very bad category was 2.3% for one student. In general, the score shows that VHS students' ability in the state of Seyegan is in the very good category (56.8%). Distinguishing students who cannot read orthogonal projection images are students who can answer more than 75% correct questions. The follow-up and suggestions from this research are that teachers need to improve the quality of teaching and learning activities, especially in technical drawing subjects, because some students do not understand the technical drawing material being taught.

References
[1] W. Wagiran, P. Pardjono, W. Suyanto, and H. Sofyan, “Vocational Education Development Framework in 21st Century,” in 1st International Conference on Technology and Vocational Teachers (ICTVT 2017) Vocational, 2017, vol. 102, no. Ictvt, pp. 395–398.
[2] Y. Estriyanto, S. Kersten, P. Pardjono, and H. Sofyan, “The missing productive vocational high school teacher competency standard in the Indonesian education system” *J. Tech. Educ. Train.*, vol. 9, no. 1, pp. 26–44, 2017.

[3] Samidjo, Setuju, Suparmin, and B. R. Setiadi, “The Empowerment Model Of Terminated Contract Workers As Creative Industry Enterpreuner,” *Int. J. Psychosoc. Rehabil.*, vol. 24, no. 10, pp. 947–953, 2020.

[4] M. B. Triyono, L. Trianingsih, and D. Nurhadi, “Students’ employability skills for construction drawing engineering in Indonesia,” *World Trans. Eng. Technol. Educ.*, vol. 16, no. 1, pp. 29–35, 2018.

[5] Mujiarto, A. Djohar, and M. Komaro, “A Design of Innovative Engineering Drawing Teaching Materials,” *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 306, no. 1, 2018.

[6] A. Nuryanto, N. S. Rahayu, and B. R. Setiadi, “The development of mechanical drawing job-sheet for vocational high school instructional,” *J. Phys. Conf. Ser.*, vol. 1446, p. 012013, 2020.

[7] T. A. Sutikno, “Cooperation between vocational high schools (VHS) and industry to increase the number of hired graduates: Multi-case study on three VHSS,” *Glob. J. Eng. Educ.*, vol. 16, no. 3, pp. 141–145, 2014.

[8] G. T. Sato and S. Hartanto, *Menggambar Mesin*. Jakarta: PT. Pradnya Pramita, 1986.

[9] K. Ko and T. Sakkalis, “Orthogonal projection of points in CAD/CAM applications: an overview,” *J. Comput. Des. Eng.*, vol. 1, no. 2, pp. 116–127, 2014.

[10] R. Mursid, “Pengaruh Model Pembelajaran Berbasis Konstruktivistik dan Kemampuan Spatial Visualization Terhadap Kompetensi Menggambar Proyeksi Orthogonal,” *ITP - J. Teknol. Pendidik.*, vol. 18, no. 3, pp. 215–229, 2016.

[11] F. A. Ristadi and Y. Ngadiyono, “Pengembangan Model Pembelajaran Berbasis CTL untuk Meningkatkan Kompetensi Menggambar Berbantuan Komputer (CAD) Siswa SMK,” *J. Din. Vokasional Tek. Mesin*, vol. 2, no. 1, p. 73, 2017.

[12] G. Wibisono, B. S. Wijanarka, and H. Theophile, “The Link and Match between the Competency of Vocational High Schools Graduates and the Industry on CAD/CAM and CNC,” *J. Pendidik. Teknol. dan Kejuru.*, vol. 26, no. 1, pp. 26–34, 2020.

[13] J. W. Creswell, *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, Fourth Edi. SAGE Publications, 2013.