Analysis of Electrical Drawing Ability with Autocad Based on Core Skills and Work Abilities: A Case Study on Electrical Engineering Education Students at the Indonesian Education University

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Abstract

The ability to design engineering drawings using Auto CAD (Automatic Computer Aided Design) is a major issue needed in work for contractors and planning consultants. This study aims to determine the level of students' ability in making engineering drawing designs using AutoCAD Students who take engineering drawing courses are adjusted to the competency of certificate IV in Engineering Drafting according to the AQF (Australian Qualification Framework) standard, the competency unit taken is Operating a computer-aided design system (CAD) and producing basic drawing elements. Evaluation is used with tests designed based on three levels: advanced beginner, capable, and proficient. Furthermore, the test results are reviewed according to the level of ability Foundation skill, and employability skill The results of this study show the ability of students in drawing with Auto CAD, for advanced beginners and capable, their abilities are high, while the ability at the proficient level is still low. this is used as feedback for improving learning and developing further research.

Keywords: Engineering Drawing, AutoCAD, Core Skill, Employability Skill.

Technical drawing learning in higher education has used AutoCAD software (Giorgobiani 2013; Moustafa, Mohamad, and Alfuraih 2019) with basic drawing material, simple building drawings, three-story building drawings, and higher building drawings (Khoroshko 2020). The use of AutoCAD (Automatic Computer Aided Design) software with the help of a personal computer or laptop, which is carried out in schools or universities, in designing drawings can show the shape of the object and the dimensions according to the actual shape. (Indera Irawan 2017; Moustafa, Mohamad, and Alfuraih 2019).

One of the computer programs that can be used as a learning medium is Auto CAD, a package program capable of automating computers so that the computer can function as a tool in design and construction. (Indera Irawan 2017). Technical drawing skills are expected to be built on foundation skills or core learning skills consisting of literacy (reading and writing), oral communication, and numeracy (counting). (Mclean and Wyse 2012). In addition, drawing skills can be built with employability skills, namely work skills including navigating the world of work, interacting with others, and getting the work done. (Khoroshko 2020; Second Edition January 2013).

THEORETICAL REVIEW

A. Engineering Drawing and AutoCAD

Electrical Engineering Drawing is a compulsory course in the Department of Electrical Education, Universitas Pendidikan Indonesia. Students are expected to have basic drawing skills, and design drawings of simple and multi-story building electrical installations. Design drawings using Auto CAD software. AutoCAD comes from the words Automatic Computer Aided Design, which means AutoCAD is a computer program as a tool in the design or planning process (Atmajayani and Nahdlatul 2018).

Auto CAD is the main professional choice for image design, the use of this device makes it easy for the main design, efficiency, accuracy, ease of modify, image rendering characteristics, and size accuracy, and for three-dimensional and two-dimensional images, it has excellent characteristics. (Eteli and Eniekenemi 2016). Personal computers are the most important modern means of using AutoCAD for design and technological activities, information, modern production, science, and especially technical college education. (Khoroshko 2020).

B. Foundation Skill

Technical drawing learning is built on the basis of core skills and employee bility skills.

According to the Australian core skill framework, core skills have levels 1 to 5. In learning, the application of these levels depends on the goals to be achieved. The following is a core skill framework that can be applied in training or learning.
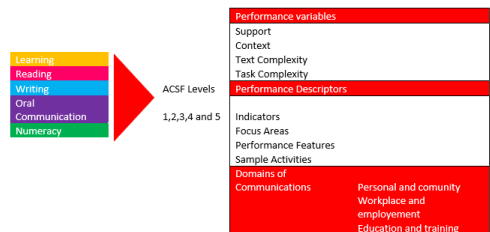

Figure. 1 Foundation Core Skill Pattern (Mclean and Wyse 2012)

Foundation skills are divided into LLN (Learning, Literacy, and Numeracy) and Oral Communication. The implementation is carried out in different contexts. The four variables are explained in ACSF including Support, Context, Text Complexity, and Task Complexity, each has a level of ability from 1 to 5. For competency tests, ability characteristics can be designed according to the needs of the workplace.(Mclean and Wyse 2012)

Learning (Belajar) ; is a complex internal process, which involves affective elements, in the affective dimension relating to attitudes, values, interests, appreciation and adjustment of social feelings. (Indera Irawan 2017) The process of changing behavior through experience and practice (Eteli and Eniekenemi 2016) The process of change through reaction to a situation faced with the characteristics of changes in activity. (Giorgobiani 2013)

Reading is a process that contains physical and mental components. Along these lines, it can also be translated as a methodology that gives importance to visual images. (Mclean and Wyse 2012). Writing (Menulis); Writing is one of the most important things to do in school. Good writing skills play a vital role in success, whether

it is writing reports, proposals, or school assignments. (Mclean and Wyse 2012)

Numeracy (Numeracy/Counting); Numeracy literacy has knowledge and skills including; Using numbers and symbols related to mathematics in solving everyday problems b. Examining the information displayed to make decisions (Mclean and Wyse 2012). Another definition is the ability to manage numbers and data 33 and evaluate statements that involve mental estimation according to problems and reality. (Mclean and Wyse 2012). Oral Communication (Oral Communication); Oral communication is a form of communication by saying words verbally or directly to the person you are talking to.

C. Employability Skill

Skills for Work Development CSFW (Core Skill for Work) is a person's ability to do work. Based on the knowledge, expertise, and abilities possessed by the person. Employability skill aspects: Navigate the world of work, Get work done, Interact with others (Mclean and Wyse 2012). Next, core skills and employee skills are grouped based on a person's performance capability level with levels 1 to 5:

Level 1 (Novice): A beginner in managing a career and work life

Level 2 (Advanced Beginner): Advanced beginner in managing a career and life

Level 3 (Capable): A person who is capable of managing a career and life

Level 4 (Proficient): A player who is skilled in managing a career and life

Level 5 (Expert): An expert in managing a career and life.

D. Workforce Qualifications

There are many types and levels of qualifications that can be taken by someone. Each qualification has several core competency units and elective units that must be taken to obtain the appropriate certificate. Training and competency testing on Certificate IV in Engineering Drafting, a person must complete training and exams with 4 core competency units and 11 elective units (www. https:

Training.gov.au). The elective competency units on the certificate are determined to be 11 units shown in Table 1. For research purposes in Electrical Engineering Drawing training, only one competency unit is taken, namely MEM30031A.

Table 1: Selected Competency Units in Certificate IV

Unit Code	Unit Title
MEM09002B	Interpret technical drawing
MEM09201A	Work effectively in an engineering drafting workplace
MEM09202A	Produce freehand sketches
MEM09203A	Measure and sketch site information
MEM09204A	Produce basic engineering detail drawings
MEM09205A	Produce electrical schematic drawings
MEM09210A	Operate computer-aided design (CAD) system to produce basic drawing elements
MEM09220A	Produce basic engineering drawings
MEM09221A	
MEM30031A	Operate computer-aided design (CAD) systems and produce basic drawing elements.
MEM30032A	Produce basic engineering drawings
MEM30033A	Use computer-aided design (CAD) to create and display 3-D models.

(MEM40412 Certificate IV in Engineering Drafting n.d.)

RESEARCH METHOD

a. Research Treatment

This study uses a descriptive research method. The subjects of the study were students who had taken engineering drawing lessons using AutoCAD. Data were taken from two classes with a total of 96 students. Students were given 4 meetings of learning, each meeting 100 minutes, drawing assignments 100 minutes, and at the end of the learning a test was given.

b. instrument preparation

The learning materials and instruments taken in this study were taken from Certificate IV in

Engineering Drafting competency training materials code MEM40412. This qualification involves the creation of detailed drawings following engineering designs and established standards. The ability to use CAD and industry knowledge is required to produce models, drawings, and schematics for specialized engineering fields. Students also need to understand engineering principles, have good mathematical skills, and have the ability to draft correctly according to designer specifications and applicable standards (MEM40412 Certificate IV in Engineering Drafting n.d.)

Furthermore, the competency taken according to Table 1 is then applied for data collection is the competency unit code

MEM30031A: Operate computer-aided design (CAD) system to produce basic drawing elements. The test is designed in the form of Engineering drawing design questions adapted based on Capable (level 3), Proficient (level 4) and Expert (level 5) abilities, the level of difficulty of the questions is adjusted to the level.

c. Research data collection

In carrying out the test, each student is given three types of tests, with different times and the test duration for each level is 120 minutes.

d. Data processing and analysis

This research data is mapped according to the measurement results based on the Foundation Skill (LLN) classification and Employability Classification, as mapped in Table 2 below.

Table 2 Engineering drawing ability test assessment format

Code and Unit Competence	Foundation Skill (LLN)					Employability Skill		
MEM30031A Operate computer-aided design (CAD) system to produce basic drawing elements	Lear ning	Rea ding	Wri ting	Nume racy	Oral Comuni cation	Naviga te the World of Work	Interact with Others	Get the Work Done
	level	level	level	level	level	level	Level	level
Confirm drawing requirements	3,4,5	3,4,5	3,4,5	3,4,5		3,4,5	3,4,5	3,4,5
Identify key features of CAD software	3,4,5	3,4,5	3,4,5	3,4,5		3,4,5	3,4,5	3,4,5
Access software and set up for drawing work	3,4,5	3,4,5	3,4,5	3,4,5		3,4,5	3,4,5	3,4,5
Produce basic drawing elements	3,4,5	3,4,5	3,4,5	3,4,5		3,4,5	3,4,5	3,4,5
Complete CAD operations	3,4,5	3,4,5	3,4,5	3,4,5		3,4,5	3,4,5	3,4,5

The test score categories of the foundation skill and employee behavioral skill straw items can be grouped based on the following table. No Criteria Descriptive Analysis Percentage

Table 3. Expertise Criteria Categories

Criteria	Presents
Very good	81% - 100%
Good	61% - 80%
Enough	41% - 60%
Weak	21% - 40%
Very Weak	0% - 20%

e. Discussion

The test result data is grouped by level and data analysis is carried out on each level. The discussion is conducted by analyzing each measurement result based on relevant previous research studies.

RESULT AND DISCUSSION

For this study, the test was made in the form of essay questions with three different levels of capable (level 3) proficient (level 4), and expert (level 5). The test was conducted on Electrical Engineering Education Students in Class A and B Class of 2019 totaling 96 students. Each test refers to the competency unit MEM30031A Operate computer-aided design (CAD) system to produce basic drawing elements and is observed

based on unit elements and unit criteria. The findings of this study are expected to be able to be used as a comparison for research products based on project-based learning as researched by

(Dos Santos et al. 2018) Test scores are grouped based on Foundation skills and Employability skills. The following are the results of the Foundation Skills test.

Table 4. Average Test Score for Foundation Skills Drawing with AutoCAD

MEM30031A Operate computer-aided design (CAD) system to produce basic drawing elements	Learning			Reading			Writing			Numeracy			Oral comunication		
	Level			Level			Level			Level			Level		
	3	4	5	3	4	5	3	4	5	3	4	5	3	4	5
Confirm drawing requirements	90	72	70	90	74	65	85	70	68	90	76	67	88	70	67
Identify key features of CAD software	85	78	67	80	75	67	85	75	68	88	77	66	86	73	70
Access software and set up for drawing work	83	74	65	87	72	68	90	75	64	90	78	65	84	80	65
Produce basic drawing elements	89	77	60	86	77	64	85	73	56	85	75	68	88	76	58
Complete CAD operations	86	72	59	89	75	56	83	73	58	83	70	64	87	72	57
average	86,6	74,6	64,2	86,4	74,6	64	85,6	73,2	62,8	87,2	75,2	66	86,6	74,2	63,4

The test results in Table 4, Capable has an average test score of learning 86.6; reading 86.4 writing 85.6; numeracy 87.2, and oral communication 86.6. These test results provide a very good score picture, because the level of difficulty and complexity of the test is still simple, so students find it easy to develop the concept of LLN (learning, writing literacy, numeracy) in studying questions at the capable level. These findings can be analyzed both theoretically and practically regarding engineering drawing skills, as has been studied by (Barata Marques and Baptista 1990). When the test questions were developed at level 4 (proficient), the average test score was below 80, namely: learning 74.6; reading 74.6 writing 73.2; numeracy 74.2, and oral communication 74.2.

Test scores for level 5 (expert), the level of questions are more complex and require a high level of understanding, so the average student test score is below 70, in detail the LLN test scores are learning 64.2; reading 64; writing 62.8; numeracy 64.6 and oral communication 63.4. The ability of students to create drawing designs using AutoCad, the higher the difficulty of making designs and the lower the foundation skill ability. These findings are expected to provide an empirical picture of how to improve students' competence in mastering AutoCad in the field of Electrical Engineering, as has been researched by (Zhang 2018). Characteristics of student skills in drawing Engineering using AutoCAD based on the Capable, Proficient, and

Expert levels of ability studied according to core skills are displayed in the following graph.
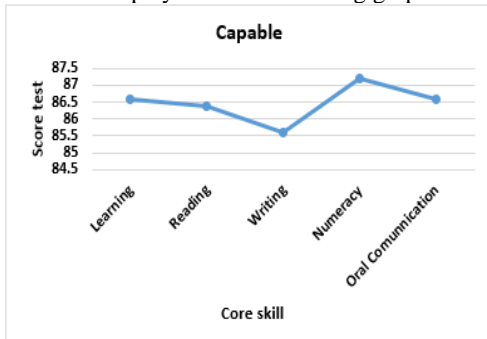

Figure 2. Core Skill Performance for Capable Level

At the capable level, the learning, reading, numeracy, and oral communication skills have an average tendency to be the same with a value of 86. Writing tends to be lower than other skills. The writing score is at 85.6. The highest score is 87.2 in numeracy skills. This finding strongly supports research conducted by (Zhang 2018).
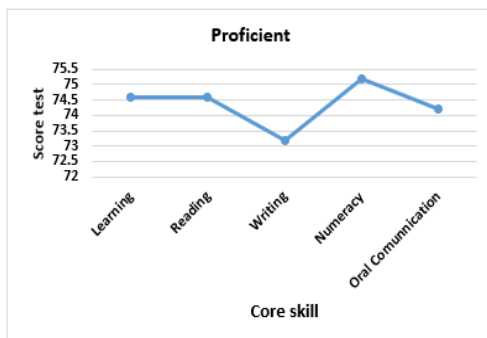

Figure 3. Core Skill Performance for Proficient Level

Meanwhile, at the proficient level, the learning, reading, numeracy, and oral communication skills have an average of 74.2. While writing is at 73.2. The highest value is in numeracy skills at 75.2.

Figure 4. Core Skill Performance For Level

For the expert level, the learning, reading, numeracy, and oral communication skills average 63.87. While writing is at 62.8. The highest value is in numeracy skills at 66. The core skill data of students' abilities in designing technical drawings still has a lower level than the score needed to get Certificate IV. For the lowest level (capable), the average value is 86.48. This value is included in the very good category. This finding strengthens the research results from (Liu 2015). While for the highest level (expert) it is at 64.08. The average value for the intermediate or proficient level is between the capable and expert levels at 74.36. The data on student test results, in drawing Engineering using AutoCAD related to employability skills are displayed in the table below.

Table 5. Average Employability Skills Test Score Drawing with AutoCAD

Employability Skill								
MEM30031A Operate computer-aided design (CAD) system to produce basic drawing elements	Navigate the World of Work			Interact with Others			Get the Work Done		
	Level			Level			Level		
	3	4	5	3	4	5	3	4	5

Confirm drawing requirements	90	75	65	85	73	65	85	70	50
Identify key features of CAD software	85	72	65	90	70	60	83	75	54
Access software and set up for drawing work	83	73	63	85	76	64	89	72	65
Produce basic drawing elements	80	71	60	79	74	62	86	77	66
Complete CAD operations	80	70	65	75	70	62	85	74	68
Average	83,6	72,2	63,6	82,8	72,6	62,6	85,6	73,6	60,6

In Table 5, the test results for the advanced beginner level (level 3), Navigate the World of Work 83.6; Interact with Others 82.8; and Get the Work Done 85.6, overall the average for this level is 84. While for the capable level (level 4), Navigate the World of Work 72.2; Interact with Others 72.6; and Get the Work Done 73.6, the average score for this level is 72.8. Furthermore, for the expert level (level 5) Navigate the World of Work 63.6; Interact with Others 62.6; and Get the Work Done 60.6. The average is 62.3.

For employability skills, the beginner level is higher than the capable and expert levels, meaning that students find it easier to work on advanced beginner-level questions, this is because the level of difficulty for this level is lower, while for the capable and expert levels, the level of difficulty is higher. It is hoped that these findings will be able to answer the research challenges carried out by (Dos Santos et al. 2018).

CONCLUSION

Competency test results for competency unit MEM30031A Operate computer-aided design (CAD) system to produce basic drawing elements, for students with 400 minutes of training (4 meetings). The core skill abilities for the capable, proficient, and expert levels have the same characteristics on average, following the demands of Certificate IV in Engineering Drafting, namely learning, reading, writing, numeracy, and oral communication abilities tend to have the same characteristics. The average core skill for capable is categorized as very good, proficient is categorized as good, while the core skill for the expert level is categorized as sufficient. Overall, students' abilities in the field of engineering drawing are at the capable level. While at the proficient and expert levels, further development is needed. From the findings of this research, there are several recommendations as follows:

1) It is necessary to develop technical drawing teaching related to core skills and employability skills at the proficient and expert levels so that graduates are ready to work in the field.

2) Further research is needed on other courses to obtain information on student abilities based on ACSF.

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