The proofing validation of conventional mechanical drawing job sheet

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Abstract. The research aims to develop and assess the feasibility of a Job Drawing course in Mechanical Drawing (MD) in the Department of Mechanical Engineering Education, Yogyakarta State University (DMEE-UNY). This study uses the 4-D Thiagarajan model. The study was conducted at DMEE-UNY. Research subjects were media expert lecturers, content experts, and student responses. Data collection techniques using interviews and questionnaires. The questionnaire was used to evaluate the validation of expert lecturers and student responses. Data were analysed descriptively quantitatively. The results showed that the development of the job sheet was successfully carried out by the MD Semester Learning Plan (SLP) in DMEE, consisting of 43 drawing tasks divided into 13 sections. The level of eligibility of the MD course's job sheet from the validation of content expert lecturers, media experts, and student responses stated that it was very feasible.

1. Introduction

Industrial Revolution 4.0 is the right era to develop the science of drawing. Currently, drawing techniques are done with computers with CAD (Computer-Aided Design) software [1]. Through computer assistance, the drawing process can be done more quickly and practically in revising images [2], [3]. CAD is software to assist in creating, modifying, and analysing a product or part. [4]. Other functions are making designs, collecting ideas, making sketches, making models, making detailed drawings, analysing designs to making simulations or animations. Today, the industrial world already uses 3-dimensional CAD software instead of using manual drawings [5].

The world of engineering, especially in the field of Machining Engineering has several vendors to draw 3-dimensional CAD, including Solid Works, Autodesk Inventor Professional, and CATIA [6]. Although it is considered quite easy and fast in using the software, a drafter must not forget the basic rules in Mechanical Drawing (MD) [7]. Before being able to operate CAD, a drafter is required to have to understand the basics and rules in MD. These basics are needed because international standard rules are a way to communicate. This can convey messages through working drawings made by draftsmen [8].

Department of Mechanical Engineering Education (DMEE) UNY is a department that prepares its graduates to become educators and workforce in the industrial world, especially manufacturing. DMEE-UNY students are required to take MD courses before obtaining a 3-dimensional CAD course, and this is intended so that all students can understand and comprehend the basic rules in drawing techniques. The material provided in MD courses is in the basics of drawing techniques such as drawing equipment,
drawing paper sizes, letters and numbers, line types, drawing scales, etiquette, American and European projections, geometric constructions, dimensions, cuts, openings, tolerances, marks workmanship, welding symbols, part drawings, composition drawings and auxiliary views.

The problem found in the department is not yet upgrading the job sheet used in drawing techniques. In terms of content, it does not accommodate the needs of drafter graduates at this time. For this reason, the use of instructional media in MD lectures needs to revise and validate job sheet modifications to fit the characteristics of student needs. Job sheets can be used as teaching materials that are arranged systematically, including assigning and evaluating, to achieve competence. [9]. However, the use of job sheets as a reference for giving MD assignments to students is expected to be a solution to the problems at DMEE-UNY

2. Research Method
This research uses research and development with the Four-D model development step (define, design, develop, and disseminate) [10]. The define stage consists of four steps: initial analysis, student analysis, material analysis, and analysis of learning objectives. The design phase consists of 3 steps including the preparation of the content outline, format selection, and scriptwriting. The develop phase consists of 2 steps, namely the product feasibility test by expert lecturers and field trials. Disseminate stage is the distribution of products that have been developed after being declared eligible for use. The research subjects were content experts, media experts, and 2018 DMEE Bachelor Program students. The object of the study was the MD job sheet. Determination of the number of study samples using the Slovin formula with a 5% error margin. The total population is 82 with a total sample of 68 people.

The research data is divided into two, namely quantitative data based on an assessment questionnaire by research subjects using a Likert scale and qualitative data in the form of comments, criticisms, and suggestions from research subjects which are concluded as input for revising the product being developed — data collection techniques in the form of a questionnaire with four answer choices on a Likert scale. The instrument validator validated the questionnaire. Data is collected after being validated and declared valid by the validator. The questionnaire was used to collect respondent data related to the level of feasibility of the resulting job sheet and classify the level of product viability. The data analysis technique uses descriptive statistics with the following table classification.

| Interval Score                                      | Level          |
|-----------------------------------------------------|----------------|
| \( X \geq (\bar{X} + 1. SB_X) \)                   | Very decent    |
| \((\bar{X} + 1. SB_X) > X \geq \bar{X} \)          | Worthy         |
| \(\bar{X} > X \geq (\bar{X} - 1. SB_X) \)         | Not feasible   |
| \(X < (\bar{X} - 1. SB_X) \)                       | Very Inadequate|

Table description:
\( X = \) scores obtained from research
\( \bar{X} = \) ideal mean = \( \frac{1}{2} (X_{\text{max}} + X_{\text{min}}) \)
\( SB_X = \) ideal standard deviation = \( \frac{1}{6} (X_{\text{max}} - X_{\text{min}}) \)

3. Result and Discussion
The development product of the research was MD job sheet packages printed on A4 size paper. The total page is 128 with 70 grams HVS paper for the contents and A4 size ivory paper as a cover with a blue base colour. The resulting job sheet package consists of a cover, procedure, general instructions for use, table of contents, main part and bibliography. This job sheet package consists of 43 drawing tasks that are divided into 13 parts. In Part 1, the subject matter covered is letters, numbers and various etiquette. Part 2, the subject matter covered is drawing lines, technical drawing tools, functions and uses of drawing tools. Section 3, the subject matter discussed is geometry construction. Section 4, the subject matter discussed is the drawing of the pipe opening, the cone and the shape of the transformer. Section 5, the subject matter covered in the quadrant perpendicular projection I (European projection). Section
6, the subject matter that is discussed is the projected perpendicular quadrant III (American projection). Section 7, the subject matter covered is axonometric projection. Section 8, the main material discussed is front views, aids and detailed views. Section 9, the subject matter discussed is the view of sliced objects. Section 10, the subject matter covered is affixing sizes, measuring lines, arrows, notations and working drawings symbols. Section 11, the subject matter discussed is the mark of work, price and linear tolerance area. Section 12, the subject matter discussed is tolerance of geometry and welding symbols. Section 13, the subject matter discussed is designing and producing working drawings of machine components.

The compilation of parts of the job sheet package is sorted according to the MD Course Semester Learning Plan (RPS), which contains the number of lecture meetings, sub-subjects of learning (SLA), subject matter, learning models, time, achievement indicators, and weighting of grades. Each of these main sections contains competencies, a list of subject matter, learning objectives, tools and materials, work steps, assessment rubrics, grading tables, and drawing assignments.

The results of development research refer to the Four-D development model. This product consists of 13 sections which each section contains competencies, a list of subject matter, learning objectives, tools and materials, work steps, assessment rubrics, grading tables and drawing assignments. The material loaded is adjusted to the RPS of technical drawing subjects, namely letters and numbers, lines and drawing tools, geometric constructions, openings, quadrant I projections, quadrant III projections, axonometric projections, auxiliary and detailed views, sliced views, affixing sizes, linear tolerances and work marks, geometry tolerances and welding symbols, and designing working drawings. The results of the MD Job Sheet Package assessment by expert lecturers and overall student responses are included in the very feasible category. Data on the results of the MD job sheet package are presented in Table 2.

| Assessment Aspects       | Score | Categories   |
|--------------------------|-------|--------------|
| Content Expert           | 139   | Very good    |
| Media Expert             | 69    | Very good    |
| Student Response         | 88.43 | Very good    |

Content expert lecturers stated that the products developed were in the very feasible category, viewed from the aspect of content eligibility with a percentage of eligibility of 86%, a linguistic aspect with a percentage of 95%, a display aspect with a percentage of 95%, and a 96% benefit aspect with an overall average of content expert are 93%. Percentage histograms of content expert ratings are presented in Figure 1 below.

![Figure 1. Histogram percentage of content expert assessment](image)

Media experts claim that the products developed are in a very feasible category. This is based on an assessment of the display aspect with a percentage of 88%, the ease of use aspect with a percentage of 94%, the consistency aspect with a percentage of 83%, the format aspect with a percentage of 83% and
the graphic aspect 83% with an overall average of 86.2 media experts %. A percentage histogram of the media expert judgment is presented in Figure 2 below.

Figure 2. Histogram percentage of media expert assessment

Student responses stated that the product developed was in the very feasible category, seen from the aspect of presentation with a percentage of 85.5%, the language aspect with a percentage of 82.5%, the aspect of graphic with a percentage of 88.5%, the aspect of convenience and benefits of the percentage of 83.5 % with an overall average of 85% student responses. A percentage histogram of student response assessments is presented in Figure 3 below.

Figure 3. Histogram percentage of student response assessment

The results in the figure above show that MD requires an improvement in job sheets with comprehensive material [11]. The next challenge is how to develop MD worksheets that can be sustainable to produce a variety of various drawing work problems. Job sheets can be a suitable medium for students to make drawing practice easier [12]. Also, an upgraded job sheet will always enrich the student experience by adjusting the needs of the drawing world in the industry. Provision of these skills can be a capital for students to step in the process of drawing technical work with the help of 3D CAD software.

4. Conclusion
MD course job sheets are developed according to the Four-D development model, including define, design, develop and disseminate. The product of this research is a technical drawing job sheet package. The level of eligibility for a job sheet is determined by the content expert assessment, media expert rating and student response. The results of the assessment by content experts obtained a total score of 139 with a percentage of 93%, which is included in the very feasible category. The results of the assessment by media expert lecturers obtained a total score of 69 with a percentage of 86.2% which included in the very feasible criteria. Assessment of student responses obtained an average score of
88.43 with a percentage of 85% included in the very feasible criteria. Based on the results of the feasibility test, trials, and dissemination showed a positive response.

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