Experimental design to see the understanding of the concept of practicum of refinement processes in regular and dual systems class of textile chemistry students

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Abstract. Curriculum changes are common in educational institutions, including in polytechnics. This change in curriculum certainly has an impact on changes in the order of courses, syllabus preparation, learning models, and others. One of the affected subjects is the practicum refinement process. This study to see design experiment on dual system class and regular class specially to see the understanding of the concept of practicum of refinement processes. The subjects study were 36 students (18 regular class students and 18 dual system class students) textile program of chemistry major in one of the polytechnics in Bandung. Instruments used in the form of observation, questionnaires, interviews, and test. From the statistical calculations it can be concluded that there is a relationship between the experimental activities and students’ understanding of concepts and there are significant differences in understanding of concepts between the regular class and the dual system class after the application of the experimental design is carried out.

1. Introduction

One of the textile polytechnics in Bandung in the last five years underwent two curriculum changes, namely from the regular curriculum in 2015 to the dual system curriculum in 2019. The change in curriculum was based to welcome the industrial 4.0 revolution which in several countries this revolution has been running for some time. Preparation of human resources in the Industrial 4.0 era certainly must be hastened with effective and efficient breakthroughs, one of which is implementing vocational education and vocational education with a dual system model. The use of this model means involving the industry and businesses to join in preparing human resources as needed, combining schools and training (internships). The dual system of polytechnics according to the Higher Education Research and Technology is an education system where students get campus integrated learning and industry practice [1]. This is in accordance with the 2018 Higher Education policy Mismatch skills and the characteristics of vocational learning, namely learning developed jointly with professional or industry associations. Dual systems are specific structural and didactical patterns of vocational learning. Normally, they are referred to as systems of initial training, which can basically happen in three ways: (1) by attending a full-time vocational education and training (VET) course in a school, college, or higher education institution with neither a training or an employment contract involved; (2) by gaining specific skills or competences in a company based on contractual employment (trainee or employee) – and therefore in a job-specific environment (learning on the job); or (3) by entering a VET program, for example, an apprenticeship, which uses (part-time) school-based and company-based modes of learning and
therefore works as a dual system in a wider understanding of the term [2]. At the same time, the introduction of the dual system involves a fundamental change in the organization of process of training of the future teachers of the dual training which is based on rational combination of theoretical training in higher education institutions and expanded manufacturing practice in enterprises and organizations [3]. The central goal of VET in the dual system is to help students attain and develop competence in action so that they can meet current and future [4].

Change of curriculum certainly have an impact on the distribution of courses, one of the affected subjects is the Practice Improvement Process course, where the regular curriculum (regular class) is held in the third semester while the dual system curriculum in the second semester (dual system class). The purpose of this learning is to equip students with knowledge of technology improvement so that students are able to have the skills to carry out operations preparation process of improvement. The material provided includes the process of burning the feather, removing starch, cooking, bleaching, stabilizing heat, weight reduction and relaxation on various fibres [5]. This change in curriculum also had an impact on the experimental design carried out in the laboratory, bearing in mind that in the regular class the practicum held 16x meetings spread over 4 months, whereas in the dual system curriculum 16x meetings were spread over 6 days / one week.

Many designs or practical models can be done in the laboratory [6]. The differentiation and personalization of the content of teachers vocational training of dual education systems is focused on: professional mobility and choice of variety of levels of professional qualifications by students, further specialization which is achieved by elective courses, special courses and seminars [4]. The created dual system of future specialists training at the university which are represented in the model, focused on the real needs of the laboratory market, individual companies, implementation of social and career expectations of students [3]. In our view, it helps to implement the interaction of universities, vocational training institutions and enterprises on a qualitatively new basis, and improve the quality of teachers-organizers training of dual training in VET systems [5].

In practice, experiment activities in regular curricula / regular classes can be performed using several models. Experiments in the field of science are identical to scientific research or research studies [6] which is also called the inquiry learning model. The learning model with scientific inquiry has five stages: 1) finding the problem, 2) getting the data, 3) collecting the data experiment, 4) formulating the explanation, 5) analysing the data of investigation process. The Project Based Learning (PBL) model has several stages / syntax that is 1) determine the fundamental questions; 2) make project design; 3) arrange scheduling; 4) monitoring project progress; 5) assessment of results; and 6) evaluation of experience [8]. There’s a lot less than these is wPBL model [9]. Cook books experimental design / authentic recipe like laboratory, students get the steps that must be done during the practicum [6]. In the inquiry model, one of the approaches that can be applied is the Skills Process of Science (SPS), that includes stages: 1) defining problems, 2) formulating hypothesis /estimation, 3) determining the variables, 4) adequate testing, 5) collecting data, 6) display data, and 7) describing the results[6]. Most commonly, though, fully education-side programs tend to be unrelated to the current state of the field, with limited opportunity for practical experience and major challenges finding skilled teacher-trainers. Students learning practical content in classrooms might not get the right mix of skills, or find out too late that they do not enjoy working in their occupation. Educators cannot know how and when to update as technology and demand changes nor should they, since their job is education, not business-cycle and technology monitoring [5].

The syllabuses Vocational dual system must consist of three sections 1) states the general educational purpose of vocational schools and the governing principles of the teaching. 2) sets out the legal framework specific to the occupation for which training is to be provided, as well as its aims and principles. 3) the contents and aims of teaching are structured by learning areas, and no longer by subjects [10]. Learning areas are areas of action that are didactically based and adapted for teaching’ skills.

Implementation of the project and inquiry [12] is also able to increase students' understanding of the chemistry of natural materials [11]. Project-based learning can not only improve students’ learning motivation in vocational schools but also facilitate their problem-solving skills [13]. This model is able to improve soft skills and improve student data collection and analysis [14]. For the instructional
treatment, the guided-inquiry-based approach was more effective than the traditional recipe-like approach both authentic and virtual environments. Based on the presentation of the literature study, it is necessary to design the learning that can answer the outcome of the process improvement laboratory [15]. The study aims to know understanding of the concept of practicum of refinement processes by dual system class and regular class.

2. Method

This study used descriptive study [16] on students majoring in textile chemistry as much as 36 people (divided into 2 big groups) in one of Polytechnic in Bandung. The students were enrolled on a process improvement experiment course in the third semester of 18 people (Regular Curriculum) and 18 students in the second semester (dual system Curriculum). The research data was obtained through observation of the lab activity and test. The study was conducted for 32 meetings (16 meetings in the regular curriculum and 16 meetings in the dual system curriculum) on the implementation of practice process improvement. The practice design that is done in the table 1

| Curriculum used | students | Meetings            | Curriculum used | Students | Meetings          |
|-----------------|----------|---------------------|-----------------|----------|-------------------|
| Regular         | 18       | 16x 150 minutes     | Dual system     | 18       | 6 x 400 minutes   |
|                 |          | (for 4 months)      |                 |          | (for one week)    |

3. Result and Discussion

3.1. Experimental Performance Comparisons in Regular Classes and Dual Systems

From the observation result during lab activity in regular curricula (regular class) and dual system curricula (dual system class), the implementation of the process improvement laboratory is carried out by more stages. In simple stages of learning (experimental design) for regular classes and dual systems can be seen in table 2.

| Stage | Regular classes | Time (minutes) | Dual system classes | Time (minutes) |
|-------|-----------------|----------------|---------------------|----------------|
| 1     | The planning process | 150            | Preparation of the practicum | 75             |
| 2     | Making journal   | Take home      | distribution job sheet | 25             |
| 3     | Implementation of the practicum | 100           | implementation of the practicum | 180            |
| 4     | 20              | 60             | calculation         | 60             |
| 5     | calculation     | 60             | make conclusion and discussion | 60             |
| 6     | make conclusion and discussion Reporting | Take home    | Reporting           | Take home      |
|       |                 |                |                     |                |

In the regular class in detail the stages are: 1) planning the process, including practicum briefing for one semester, planning of textile materials to be tested during the practicum (Polyester, cotton, and blends) as well as the process to be carried out including designing, scouring, weight reducing, mercerization, and bleaching and directing journal making as well as reports. 2) Students make journals that contain practical goals, flow diagrams, recipes (materials and tools), preparation of hypotheses, and work procedures 3). Implementation of practicum 4) calculation, 5) drawing conclusions and analyzing the results / discussion. Steps 3-5 are made during the practicum (150 minutes) 6) Reporting, after the practicum is finished (one week later), the students make the process improvement experiment 7). Assessment of results mid-term test and final test, which contains the understanding of concepts / materials and the lab. activity Process improvement experiment.
In the dual system curriculum / dual system class, the implementation of the practicum of the refinement process was carried out with stages that were almost similar to the regular class, only in the dual system class there was no journal making. 2) Distribution of job sheets that have been prepared by lecturers and assistants, as well as giving instructions for filling out the worksheet 3. Practical implementation 4. Calculation, drawing conclusions and analysis of results / discussion (in one meeting, 400 minutes completed 2-3 practicum titles 6) make a report after 7 practicum titles are completed, usually on the 4th day. 7). The test is in the form of concept understanding, lab activities. Improvement process. From the observations it can be concluded in the regular class using inquiry learning model [6], while in the dual system class using the cook book experimental model / Authentic recipe like laboratory [6].Based on the results of observations on the implementation of the experimental design in the regular class, the regular class can be carried out without any significant obstacles, such as the preparation of various pH solutions in the process of mercerization as well as calculation. While in the dual system class is related to calculations in the calculation as well, this happens in the regular student class having received basic chemical practicum, whereas in the dual system class the basic chemical practicum is done in the same semester as the refinement process prackum. There are prerequisites that have not been delivered.

The assessment stage to be one of the important aspects of an experiment is how teachers can confirm the findings and provide feedback to students in the form of reflection activities. Assessment of the report focuses on the depth of the concept [15]. The stages of lab activities that have been done by students. Lab activities design was undertaken is a model of scientific inquiry for regular classes. Stages performed as many as 7 stages and cook book recipe experiment for dual system class.

3.2. Conceptual understanding of textile chemistry students
At the 7th stage, testing is done to understand the concepts and activities of the practicum refinement both in the regular class and the dual system class. The concepts tested are the concepts of material types (cotton, polyester and blends) as well as the process of desizing, mercerization and bleaching. Normality and homogeneity were tested both in regular class and dual system class. The test results can be seen in table 3 and 4.

| Klas     | Nilai rata-rata | Kolmogrov Smirnov | Shapiro-Wilk |
|----------|----------------|-------------------|--------------|
|          | Statistic      | df    | Síq.     | Statistic | df    | Síq.     |
| Regular  | 172            | 18    | 172     | 949       | 18    | 403      |
| Dual System | 192       | 18    | 063     | 952       | 18    | 450      |

In this test the two groups of samples were obtained normally distributed while the variance was not homogeneous. Next to see the average difference is calculated using the independent t test, and means are obtained in the regular class (77.56) and the dual system class 75.61. To see whether this mean difference is significant or not the t-test can be seen in table 5 and 6.

| Nilai rata-rata | Levene Statistic | df1 | df2 | Síq. |
|-----------------|-----------------|-----|-----|------|
| Based on Mean   | 5.710           | 1   | 34  | 0.23 |
| Based on Median | 5.563           | 1   | 34  | 0.24 |
| Based on Median and with adjusted df | 5.563 | 1 | 27.587 | 0.26 |
| Based on trimmed mean | 5.807 | 1 | 34 | 0.22 |
Table 5. Result of Means and t-Test Grup Statistic

| Class          | N   | Mean   | Std. Deviation | Std. Error Mean |
|----------------|-----|--------|----------------|-----------------|
| Regular        | 18  | 77.56  | 10.853         | 2.558           |
| Dual system    | 18  | 75.61  | 5.873          | 1.384           |

Table 6. Independent Samples Test

| Levene’s Test | t-test for equality of Means |
|---------------|-----------------------------|
| Equality of Variances | F | Siq | t | df | Siq (2-tailed) | Mean Difference | Std.Error Difference | 95% Confidence interval of the Difference |
| Equal variances assumed | 5.752 | 0.22 | 669 | 34 | 508 | 1.944 | 2.909 | -3.967 | 7.855 |
| Equal variances not assumed | 669 | 26.169 | 510 | 1944 | 2.909 | -4.032 | 7927 |

From the results of calculations with SPSS, the result of the t-value is greater than t-table. In conclusion, there is a meaningful difference in understanding of concepts between regular and dual system classes. The average understanding of concepts in the regular class and dual system class is shown in figure 1.

Figure 1. Graph of conceptual understanding regular class and dual system class

Figure 1 and the statistical calculation results in table 4 show that students’ understanding of concepts in the regular class is different / better than the dual system class. This is due to the different experimental designs in the two classes, in the regular class with the scientific inquiry model and in the dual system class using the book recipe model [6]. The use of this model by several research results [11] [12]. In the dual system class the result is lower due to the presence of part of the dual system syllabus that has not been consistent / fulfilled [10].

3.3. Materials of Chemical Practice of Improvement Process

Practical topics include the basic introduction of textile materials, namely cotton, polyester and blends (cotton-polyester) as well as some refinement processes, such as desizing, mercerization and bleaching. Cotton is currently the leading plant 1 crop worldwide and is grown commercially in the temperate and tropical regions of more than 50 countries [18]. The value-chain of cotton production has an origin in cotton crop. The cotton fibres obtained are used in producing a variety of textile products from fibre to fabric. Cotton fibres are the purest form of cellulose, nature's most abundant polymer. Nearly 90% of the cotton fibres are cellulose [19]. The time has come to place a higher priority for raising the standards in value-addition rather limiting or concentrating the approaches for increasing the fibre quantity [20]. Heating generally causes dehydration and decomposition of cellulose. Heat or reactions begin in the
more accessible amorphous regions and the surfaces of crystalline domains. The chemical reactivity of
the cellulose hydroxyl groups follows those of aliphatic hydroxyl groups. In textile processing the
concept of eco-friendly products and processes has received significant appreciation all over the world;
and the legislatory public enforcement in developed countries are known for this purpose. Indirectly,
such enforcement has partly resulted in growth and development of conventional textile processing in
developing countries where low-waged work forces and reduced environmental controls are prevalent
[20]. An image of a cotton cross section can be seen in figure 2.

![Image of cotton cross section](image)

**Figure 2.** Structure of Cotton under Microscopic Lens

Polyester fibers are Man-made fibers in which the forming substance is a long chain polymer
composed of at least 85% by weight of an ester of dihydric alcohol and terephthalic acid. Polyester
polymer is produced commercially in a two steps polymerization process, monomer formation by ester
interchange of dimethyl terephthalate with glycol or esterification of terephthalic acid with glycol
followed by polycondensation by removing excess glycol. To improve the quality of polyester, several
treatments can be carried out, including alkali treatment, organic solvent treatment and Action of non-
aqueous solvents on Polyester Fiber [21]. The picture of the process of making polyester can be seen in
Figure 3.

![Diagram of polyester process](image)

**Figure 3.** The process of making Polyester

The process of practicing the refinement process is one of them, dessizing and mercerizing. Desizing
is the process of removing the size material from the warp yarns in woven fabrics. Sizing agents are
selected on the basis of type of fabric, environmental friendliness, ease of removal, cost considerations,
effluent treatment, etc [22]. Mercerization of a process in which textiles (typically cotton) are treated
with a caustic (NaOH) solution to improve properties such as fiber strength, shrink-age resistance, luster,
and dye affinity. The caustic rearranges the cellulose molecules in the fiber to produce these changes.
Higher end fabric may be double or triple mercerized for added benefits [21].

4. Conclusion
The implementation of experiment refinement process with different experimental designs results in
understanding different concepts. Regular class experiment design uses scientific inquiry models, giving
better concept understanding results compared to the dual system class that uses cook books model. But it needs to be improved in carrying out laboratory activities, the time required is enough to carry out complete research.

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