The Effectiveness Of Using Virtual Laboratory On Practical Skills The Unit Operation Subject Student Of Chemical Engineering

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Abstract- This research was conducted to determine the ability of students to understand and apply practical skills in the Unit Operation laboratory of Chemical Engineering. Practice at the laboratory is carried out as a condition for students to study the Unit Operations courses. The assessment of practical skills is focused on psychomotor abilities and data analysis from experiments conducted by students. Do practice at the laboratory is carried out so that students can better understand the theories given during lectures. However, several obstacles cause students to be less able to understand the process contained in the experiment, because students do not understand clearly how the tools used in the laboratory, the following functions, and uses. To overcome this obstacle, this research uses technological assistance in the form of a virtual laboratory. The use of virtual laboratories in this study aims to analyze the effectiveness of practical skills in unit operation subjects. The virtual laboratory is used by students before conducting a real experiment (Hands-on Laboratory). This research uses quantitative methods with a quasi-experimental type of research. Which divides the two groups into an experimental group and a control group. From the results of the research that has been done, it is found that the use of virtual laboratories is effective in increasing the ability and practical skills of students. The virtual laboratory is very helpful for students to be able to imagine the working process of tools and experimental procedures in the laboratory.

Index Terms- virtual laboratory, practical skills, the unit operations, chemical engineering

I. INTRODUCTION

The main problem in engineering education is the lack of maximum scientific and mechanical knowledge of students and educators. The technical equipment used in the application of science has a variety of specifications, so it is necessary to understand in-depth concepts for students who study education in engineering. The right learning strategy is needed to solve learning problems in engineering. Learning problems not only arise due to students not understanding the technical-scientific concepts, but also the lack of maximum understanding of the equipment and working procedures of technical tools.

To overcome the learning problems that require visual learning, learning is developed using virtual reality. Although in the beginning the use of virtual reality was limited to the military, in subsequent developments learning using this strategy was developed in formal education. Virtual reality is used to help visualize learning. This is done to make it easier for students to understand the material or concept given. With this strategy learning that does not seem real will be easier to understand. For example, learning about how the pump works. Students will experience some obstacles in understanding how the pump works, because they do not know the devices inside the pump and how the pumping process occurs. But using animation or virtual, it can be explained in detail how the inlet and outlet procedures, as well as the pump compiler, without having to disassemble the pump-because dismantling the pump creates the risk of fatal damage and a quite expensive financing.

Virtual learning can also help students to be better prepared when entering the workforce. Especially in the engineering field, it needs workers who can operate the tools and understand how to work the industrial tools appropriately. Also, students must be able to be highly competitive with other students in the context of learning, research, and development in the community.

In the field of chemical engineering research, the virtual laboratory is implemented in the form of virtual reality. The virtual laboratory used to help clarify tools and experiments in learning. This equipment help students can conduct experimental procedures properly and correctly. The virtual laboratory is also used to clarify the work processes of technical equipment and industrial processes on a laboratory scale. This research was conducted to analyze the student's abilities and student's practical skills. The supporting facility in the learning process of this practicum is a virtual laboratory for Unit Operation of Chemical Engineering courses that can be used by students independently or with direction to maximize comprehension skills. Another goal of this study is to maximize the ability to use the virtual laboratory in the learning process, to improve the ability of individual students, to improve the cognitive abilities of students, to improve the psychomotor abilities of students in carrying out practicum manually in the laboratory and to improve the effectiveness and efficiency of the process learning. From this explanation, the researcher wants to formulate a research problem, the effective use of a virtual laboratory on the practical skills of the Unit Operations course.

II. IDENTIFY, RESEARCH AND COLLECT IDEA

Virtual Laboratory (VRL)

A laboratory is a place that is used to conduct experiments and training related to physics, biology, and chemistry, or other fields of science, which is a closed room or open space such as gardens and others. The activities carried out in the laboratory are practicum activities.

In carrying out practical activities required the ability to perform practical skills. Aspects that affect practicum skills are not only cognitive aspects, but psychomotor aspects can also play a maximal role. The things done in conducting practicum activities are preparation in learning practicum material, ability to master tools in the laboratory, mastering the steps involved must be carried out during the process of practicum activities, can make a written report on the results of trials in the laboratory.

Virtual Laboratory (VRL) is a software device that is designed to perform repeated experiments on a variable (Toth, 2016). VRL is a medium used to help understand a subject and can provide solutions due to the limitations or absence of laboratory equipment. A virtual laboratory is defined as an interactive environment for creating and conducting simulation experiments: a playground for experimenting.

VRL or virtual laboratory is a technology-based laboratory that is expected to be able to help problems in science learning that many use conventional laboratories and incur a high enough cost. Basically, researchers conducted this research to develop technology-based laboratories without completely eliminating the use of real laboratories. Learning in a laboratory where group learning provides better knowledge (Belanger, 2016). Learning in the laboratory can help students to better understand and understand, especially for learning science, engineering, computers, and so forth. The use of virtual laboratories in several different fields shows the results that there is greater interest in fields that use virtual technology (Alkhaldi, Pranata, & Athauda, 2016).

In implementing the learning strategy using VRL, educators provide direction in the use of virtual laboratories. The direction or guidance provided can be in the form of interactions in the classroom online or offline and the provision of correct work procedures. VRL can be used by students if the university experiences equipment and material constraints as well as teaching staff, so that learning objectives are still achieved despite obstacles. Virtual laboratories are used to help finalize concepts and help students with limited abilities without limiting them to scientific learning that attracts students, as well as helping the learning process become smoother with the time needed more efficiently. Besides the time needed to be more efficient, the need for practicum funding tends to be quite high. Because practicum is done repeatedly, so throw a lot of material in the experiment. If it is started by using a virtual laboratory, it is hoped that students will already simulate the experiments that will be carried out in practicum, thereby minimizing the use of excessive materials. The effective use of visual aids exhibited using a virtual laboratory compared to those not using a virtual laboratory. And the result is the use of virtual laboratories can improve the effectiveness of learning chemistry (Grmek, 2014). The use of virtual laboratories produces students who have a higher interest in learning (Pyatt & Sims, 2012). Use of virtual laboratories as laboratory applications in an interactive constructivist learning environment. The results show that chemical laboratory software is as effective as real chemistry laboratories and positively influences the facilitation of the environment (Tatli & Ayas, 2012).

Practical Skills

Practical skills are one of the psychomotor aspects that must be possessed by every student who manages courses with practicum. Assessment of the ability to do practical work in the laboratory by students is not only obtained from a cognitive assessment. The basis for assessing and analyzing practical skills is to use Bloom's taxonomy. Taxonomy comes from two Greek words tassein which means classifying and nomos which means the rule. Taxonomy means a classification hierarchy of basic principles or rules. The term is then used by Benjamin Samuel Bloom, a psychologist in education who conducts research and development on thinking skills in the learning process. Bloom's taxonomic history began when in the early 1950s, at the Conference of the American Psychologists Association, Bloom and colleagues suggested that from the evaluation of learning outcomes that were mostly compiled in schools, it turned out that the largest percentage of items raised only asked students to their memorization. The conference was a continuation of the conference held in 1948. According to Bloom, memorization is the lowest level of thinking ability (thinking behavior). There are still many other higher levels that must be achieved so that the learning process can produce students who are competent in their fields. Finally in 1956, Bloom, Englehart, Furst, Hill, and Krathwohl succeeded in introducing the concept of thinking skills called Taxonomy Bloom (Bloom's Taxonomy for E-Learning Compiled by Khan, n.d.).

Bloom's Taxonomy is a hierarchical structure that identifies skills arranging from low to high levels. To achieve higher goals, low levels must be fulfilled first. The educational concept goal by Bloom is classified into three domains of intellectual cognitive, affective, and psychomotor. Bloom's Taxonomy has encountered two changes, namely, the Bloom Taxonomy and the Taxonomy which has been developed by Andreson and KartWohl. For each discussion explained as follows, Cognitive Domains Cognitive goals or cognitive domains are those that include mental (brain) activities. According to Bloom, all efforts concerning brain activity are included in the cognitive realm.

Cognitive domain

In the cognitive domain, there are six levels of thought processes, ranging from the lowest level to the highest level which includes 6 levels including Knowledge (C1), Comprehension (C2), Application (C3), Analysis (C4), Synthesis (C5), and Evaluation (C6).

Affective Domain

The Affective Domain covers everything related to emotions, such as feelings, values, appreciation, enthusiasm, interests, motivation, and attitudes. These five categories are sorted from simple to most complex behaviors, namely Receiving - A1, Responsive (A2), Value, A3, A3, Organization A4, Characterization - A5

Psychomotor domains

Psychomotor domains include physical movement and coordination, motor skills, and physical abilities. These skills can be honed if they do so frequently. These developments can be measured in angles of speed, accuracy, distance, method/technique of implementation. There are seven categories in the psychomotor domain ranging from simple levels to complicated levels namely Impersonation - P1, Manipulation - P2, Resolution - P3, Articulation - P4, Experience - P5 According to the behavior displayed with the least amount of physical and psychological energy. The movements are carried out routinely. Experience is the highest level of ability in the psychomotor domain.

The Unit Operation

The unit operation course is a branch of engineering that studies the processing of raw materials into more useful goods, which can be either finished goods or semi-finished goods. Chemical engineering is applied primarily in the design and maintenance of chemical processes, both on a small scale and a large scale such as factories. Chemical engineering first appeared in the development of operating units, one of the basic concepts of modern chemical engineering now (McCabe, Warren L, Smith, J., Harriot, 1993). Chemical Engineering Operations is one of the mandatory courses in Chemical Engineering study programs. Chemical Engineering Operations or also known as unit operations is a basic stage in a process. The operating unit not only changes a substance such as a reaction in a chemical reactor but also physical and phase changes such as separation, crystallization, evaporation, filtration, and several other examples. For example in milk processing, homogenization, pasteurization, cooling, and packaging, each is an operating unit that is related to produce the whole process. A process can consist of many operating units to get the desired product.

Chemical Engineering Operations course is divided into 3 parts, namely Chemical Engineering Operations 1, Chemical Engineering Operations 2, and Chemical Engineering Operations 3. In general Chemical Engineering Operations studies the unit of operation in a process. Chemical Engineering Operations Course 1 studies fluid flow through pipes, fluid measurement, fluid transportation equipment, stirring and mixing, flow through immersed objects, stationary and fluidized beds, mechanical-physical separation, reduction of solid particles, and solid-solid mixing. Chemical Engineering Operations Course 2 studies the understanding of the operation of process equipment based on heat and mass transfer namely evaporation, humidification, drying, and crystallization. Chemical Engineering Operations course 3 studies the theory of separation operations, especially absorbs, distillation, leaching, extraction, and determining the basic specifications of the separation process equipment with stage-wise and packing.

Practicum in the chemical engineering department is given at low to high difficulty levels. Some of the practicums given were Basic Chemistry practicum, Chemistry Analysis practicum and Microbiology practicum in semester 2, Organic Chemistry practicum and Physical Chemistry practicum, and Chemical Engineering Operations 1 practicum in semester 3 and Chemical Engineering Operations 2 in semester 4. Practicum material given is adjusted to the learning material of each course. For the Chemical Engineering Operations 1 course, there are several practical materials, namely fluid mechanics, fluid flow, piping, piping design, solid-solid separation, sedimentation, and water treatment.

III. RESEARCH METHODOLOGY

This research uses quantitative methods with a quasi-experimental type of research. This experiment was chosen because the study did not use random, so there are two groups of subjects that have been available as is, the experimental group and the control group have been determined not chosen randomly or randomly (Setyosari, 2015). Design or research design using a pretest-posttest control group design. An experimental group is a group of students who do practical work with the help of the Virtual Laboratory, while the control group is a group This research will be conducted quantitatively on Chemical Engineering study program students as research objects because the use of virtual laboratories is very following the situation of learners and self-regulated learning is more effectively developed for students who are already adults (students). Quantitative research is carried out to calculate and infer the results of research from the sampling used. Experiments carried out for 1 semester (16 meetings or approximately 6 months) during the learning process and practicum takes place. The study was conducted at Tribhuwana Tunggadewi University in the Chemical Engineering study program at the Strata-1 Engineering Faculty. Each class contains approximately 30 to 33 students with practicum groups of each group of 5-6 people. The data analysis process is used to answer the research problem formulation. Testing the hypothesis presented in chapter I will be analyzed by using the Multivariate Analysis of Variance (MANOVA) technique using SPSS 22. The Manova Test is a Multivariate Path Analysis Test. In Manova there is more than one dependent variable. The independent variable in this study is the virtual laboratory, the independent variable is the learning outcomes and practical skills.

Research result

In this study, there are 2 groups, namely the experimental group and the control group. The experimental group consisted of 36 students and the control group consisted of 33 students. The experimental group uses the virtual laboratory in the learning process, while the control group uses hands-on laboratory or direct learning.

Between-Subjects Factors

		Value Label	N
Strategy	1	VRLs	36
	2	HOLs	33
SRL	1	High	40
	2	Low	29

From the data results, it can be seen that students who use the virtual laboratory have higher average practical skills than students who use the Hands-on Laboratory strategy

Practical Skills

Tests of Between-Subjects Effects

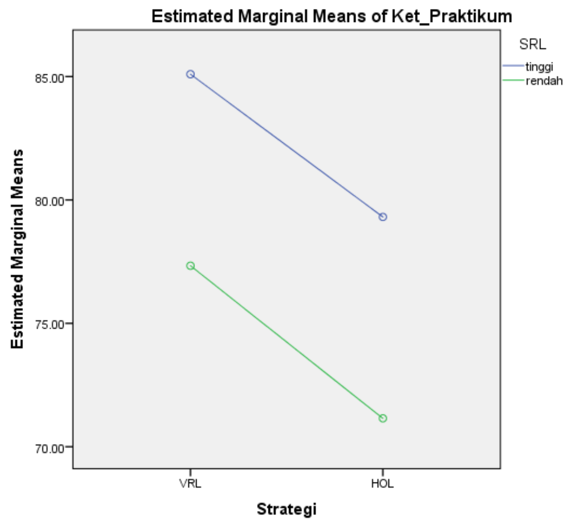
Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	Hasil_Belajar	1431.735[a]	3	477.245	23.256	.000	.518
	Ket_Praktikum	1686.390[b]	3	562.130	20.148	.000	.482
Intercept	Hasil_Belajar	393625.905	1	393625.905	19180.999	.000	.997
	Ket_Praktikum	410745.903	1	410745.903	14722.110	.000	.996
Strategi	Hasil_Belajar	338.692	1	338.692	16.504	.000	.202
	Ket_Praktikum	600.951	1	600.951	21.540	.000	.249
SRL	Hasil_Belajar	1077.396	1	1077.396	52.500	.000	.447
	Ket_Praktikum	1063.680	1	1063.680	38.125	.000	.370
Strategi * SRL	Hasil_Belajar	.286	1	.286	.014	.906	.000
	Ket_Praktikum	.667	1	.667	.024	.878	.000
Error	Hasil_Belajar	1333.908	65	20.522			
	Ket_Praktikum	1813.496	65	27.900			
Total	Hasil_Belajar	415168.880	69				
	Ket_Praktikum	433970.900	69				
Corrected Total	Hasil_Belajar	2765.643	68				
	Ket_Praktikum	3499.886	68				

a. R Squared = .518 (Adjusted R Squared = .495)

b. R Squared = .482 (Adjusted R Squared = .458)

Dari table diatas maka dapat diambil kesimpulan, bahwa ketrampilan praktikum dipegaruhi oleh

From the table behind, we have conclusion about the research. The number of Signification from practical skills show that sig. 0.000 < 0.05 means practical skills have influenced by Self-Regulated Learning. And sig. 0.878 > 0.05 shows that practical skills have interaction between Self-Regulated Learning and Learning Strategic.



Estimated Marginal Means from Practical Skills

From data. obtained 2 plot lines the effect of the Strategy on practicum skills. There is no intersection between the two VRL and HOL plots. If you pay attention from the plot, the results are obtained, that students who use the VRL strategy have higher practical skills than students who use HOL.

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