Implementation of a Website-Based Laboratory Information System to Increase the Effectiveness of Laboratory Management

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Abstract-This study aims to improve the efficiency of laboratory management through the implementation of a web-based laboratory management information system. This study used a quantitative approach with a one-group pretest-posttest design. Data collection was conducted through interviews, observations and surveys, involving 7 science teachers who use the laboratory as an infrastructure to provide an intensive understanding of science learning. The results showed that the web-based laboratory management system operated effectively, making a positive contribution to improving the efficiency of laboratory management with an N-Gain score of 92.64% indicating a very high level of effectiveness.

Keywords: laboratory; information Systems; website; laboratory management

I. INTRODUCTION

Facing the challenges of the 21st century in building the character of the Indonesian nation is a crucial agenda. Success in this endeavor will be realized when every Indonesian citizen possesses determination and resilience in the effort to advance the civilization of the nation. The 21st century is known for rapid transformation, especially in the development of Science and Technology (S&T), which brings about a paradigm shift in learning through curriculum modifications, media, and technology. The quality of learning media is key in interpreting abstract concepts for easier understanding. Information and Communication Technology (ICT)-based education is an integral element of the needs of 21st-century learning. One of the main challenges is the integration of technology as a learning aid to enhance learning skills. Education in the 21st century truly reflects the evolution of society over time. In line with the rapid digitization in society, education in Indonesia needs to adapt to remain relevant. Therefore, it is important to have an understanding of technology and the ability to implement ICT-based learning methods or models to address the challenges of current digitization trends. [1].

Schools are educational institutions that must be able to apply management to achieve their goals because management is related to the management of each individual and all activities that occur. The scope of management in schools is very broad because there are many things that can be managed in schools, for example curriculum management, student management, personnel management (educators and education staff), financing management, relationship management with the community and facilities and infrastructure management. In achieving its goals, schools should be able to study the specifics of management in each of these areas, for example in the management of facilities and infrastructure, management and activities carried out in laboratories or laboratory management can be studied.

The laboratory is a learning facility that can function as a place to train participants in understanding concepts and improving skills in conducting scientific experiments. The presence of a laboratory in the context of science or science learning is very crucial, because the laboratory acts as a place to test concepts through experiments. Students can implement experiments to test the validity of the scientific theories they study. The

laboratory is not only a place to prove theories, but also a source of learning that has many positive impacts. Through direct experience such as seeing, hearing, touching and smelling the objects being studied or analyzed, students can gain confidence in the truth of these concepts. Apart from that, the existence of a laboratory is able to arouse curiosity and enrich students' work experience and skills through scientific development [2].

Laboratories play a crucial role in supporting the educational process in schools, especially in the realm of natural sciences such as physics, biology and chemistry. The importance of the laboratory is reflected in the need to test the theories studied with actual reality. When students engage in inquiry-based learning methods, they are empowered to develop scientific skills through activities such as observation, data collection, formulating statements, generating hypotheses, designing experiments, and drawing conclusions. This emphasizes that science learning cannot be separated from practical experiences that occur in the laboratory [3].

Learning activities in the laboratory aim to develop participants' skills, such as observation skills, use of instruments, awareness of the importance of careful work, and understanding of limitations in laboratory measurements. Apart from that, this activity also aims to train participants in recording experimental results, sharing information, and encouraging analytical and critical thinking through experimental interpretation. This process will assist in developing information, strengthening integrity, and instilling an attitude of accountability. Furthermore, this activity also focuses on training participants in planning and implementing experiments [4].

In daily activities, laboratories often face various challenges, from managing complex data, tracking inventory, organizing samples, to reporting results. Without an integrated information system, laboratories can experience difficulties such as human error, delays, or lack of transparency in work processes. In some situations, data loss or confusion can have serious consequences, including inaccurate results, waste of resources, or even security risks [5].

In the educational context, the implementation and use of management information systems cannot be separated from activities related to learning. Rapid progress in science and technology, especially in the field of computerization, shows that this development is able to contribute to dealing with various challenges that arise during the implementation of educational management information systems. [6].

The laboratory management information system is a computer-based system that provides information for several users with similar needs, including study program heads, laboratory heads, laboratory assistants, teaching assistants and students. So that it can make it easier to carry out the data collection process in the laboratory from several aspects of archiving, maintenance, and borrowing goods in order to reduce errors in collecting data on goods in the laboratory. [7].

Effectiveness refers to the extent to which a social system can achieve its goals. The level of effectiveness of school resource management includes achieving goals in managing and utilizing available resources, such as teaching staff, educational staff, infrastructure and other elements. This aims to achieve school targets, create a conducive learning environment, and produce output that is beneficial to society [8].

Based on monitoring results at Brigjend Katamso II High School, Medan, researchers found that the use of the science laboratory to explore science material in class had a positive impact on students. However, there are several problems in its management. One of them is the lack of information regarding laboratory usage schedules, which causes clashes between subject teachers when conducting practicums. In addition, a lack of information regarding the availability of tools and materials, including quantity, specifications and condition, is also a problem.

Recording the use of tools and materials is done conventionally through laboratory books, but teachers often do not complete the list of tools and materials that have been used. As a result, the next teacher who uses the laboratory may not realize that the supplies of tools and materials have run out or are damaged, causing confusion in locating them in the laboratory. Apart from that, there is no reporting to the Principal regarding the process of using the laboratory within a certain period of time. Conventional methods of recording laboratory use and use of equipment and materials, such as those attached in Appendix 1, are considered less effective and are often not implemented. This raises concerns that data on borrowing/using tools and materials could be lost if the book is damaged or lost without data backup. In addition, the possibility that information about materials is no longer available because they have been used previously without being recorded is also an issue. To overcome this problem, an effective solution is

needed to improve laboratory management so that it runs well and correctly.

Based on the problems that exist at SMA Brigjend Katamso II Medan, there is a need for a web-based information system that can be used as a means of managing the laboratory in order to optimize the use of the laboratory as a learning tool. Therefore, researchers are interested in finding out how the implementation of a website-based laboratory information system can improve the effectiveness of laboratory management at SMAS Brigjend Katamso II Medan.

II. METHODOLOGY

This research uses a quantitative research approach, specifically using a one-group pretest-posttest experimental design. The aim of this design is not to differentiate the control group and the experimental group, but rather to differentiate the scores obtained before and after the experiment. The following is an overview of the design framework

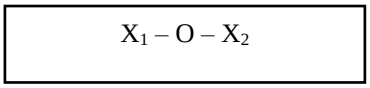

Figure 1: Design Fraework

Information:
O1 = Pretest Value (Limited Field Trial)
O2 = Posttest Score (Wide Field Trial)
X = Treatment of use of the Laboratory Management Information System

This research determines the subjects using a nonprobability sampling method. Non Probability sampling is a sampling method that does not give each element in the population an equal opportunity to be selected as part of the sample. Saturated sampling method, on the other hand, involves using all members of the population as a sample. This approach is usually used when the population is relatively small, namely less than 30 people. In another context, saturated sampling can also be referred to as a census, where all members of the population are taken as samples [9]. In this study, the research subjects consisted of seven science subject teachers (Chemistry, Physics and Biology) who taught at Brigjend Katamso II High School, Medan.

When testing effectiveness, it cannot be determined only based on post-test scores. Normalized Gain (N-Gain) analysis is suitable for use. The formula for calculating the N-Gain value is as follows [10]:

$$N_{Gain} = \frac{Score_{posttest} - Score_{Pretest}}{Score_{ideal} - Score_{pretest}}$$

Fig. 2: Formula of N-Gain

The percentage (%) of the N-Gain effectiveness category is explained as follows: < 40% is included in the ineffective category; 40 – 55% fall into the less effective category; 56-75% falls into the quite effective category; and > 76% is in the effective category [11].

III. RESULTS

The purpose of normality testing is to determine whether the data distribution has normal characteristics or not. This information is very important because it relates to the accuracy of selecting the statistical test to be used. The planned normality test will use the Shapiro Wilk test because the sample size is smaller than 50 with the help of the IBM SPSS Statistics 26 for Windows program. In the Shapiro Wilk test, a hypothesis is put forward to determine whether the data follows a normal distribution or not. Data is considered normally distributed if the significance value (Asymp.sig) > 0.05, while data is considered abnormal if the significance value (Asymp.sig) < 0.05[12].

Table 1 Normality Test For Large Fields

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
retest	.172	7	.200*	.967	7	.873
Posttest	.249	7	.200*	.825	7	.072

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Table 1 records the pretest and posttest probability values, namely 0.873 and 0.072 respectively. These results indicate that the data follows a normal distribution, as can be concluded from the normality test decision making criteria. The next stage involved a paired samples t-test to evaluate significant differences between initial conditions and final results of the laboratory management information system, which measures the effectiveness of the website during extensive field testing. Statistical analysis of the paired samples t-test was carried out using SPSS 26 for Windows software, with the following results:

Table 2 Paired Sample T-Test Data Description For Extensive Field Tests

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest	30.45	7	1.769	.669
	Posttest	72.14	7	2.478	.937

Table 2 shows the descriptive findings of the posttest and pretest statistical wide field tests. The pretest results show an average of 30.45 with a standard deviation of 1,769, but the posttest results show an average of 72.14, with a standard deviation of 2,478. Based on the average pretest and posttest scores, there is a significant difference between the effectiveness of using a website-based laboratory management information system before and after implementation. To further validate the impact of this system on the effectiveness of laboratory management at SMAS Brigjend Katamso II Medan, see table 3:

Table 3 Significance (2 –Tailed) Paired Sample T-Test

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	Pretest - Posttest	-41.693	3.822	1.445	-45.227	-38.158	-28.863	6	.000

Derived from the results of the paired T test presented in Table 3, the significance (2-tailed) value was observed to be 0.000, which means significance (2-tailed) < 0.05. So, it can be concluded that Ha is recognized, indicating a difference in the average pretest and posttest results. Therefore, it can be concluded that the use of a website-based information system has proven effective in improving laboratory management at SMAS Brigjend Katamso II Medan.

IV. CONCLUSION

The results of the data analysis test show that the N-Gain percentage is 92.64%, confirming that the implementation of a website-based information system can increase the effectiveness of laboratory management in the high category. The results of this research have proven that the implementation of a website-based laboratory information system can improve laboratory management activities in schools. One of them is that by utilizing information systems, it can reduce the administrative burden, time and resources required in laboratory management, such as inventorying all equipment and materials, scheduling laboratory use, borrowing and returning equipment and materials as well as reporting out of stock/damaged equipment and materials can be done automatically. as well as reducing the manual workload for laboratory heads.

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