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Laboratory Management on Students' Performance in Physics for Undergraduate Engineering Students

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ABSTRACT

The study entitled "The effect of laboratory management on students' performance in physics for undergraduate engineering students at Pokhara University" aims to study the effect of laboratory management on the performance of undergraduate engineering students. It adopts an explanatory sequential design under the mixed research approach in order to analyze and interpret the audio transcription of semi-structured interviews with 200 purposively selected students at the undergraduate level in the School of Engineering from 5 different colleges affiliated with Pokhara University. The analysis has taken place using SPSS-25 software after data collection. From a theoretical standpoint, this study was based on the "learning by doing" theory explained by John Dewey, having strong compliance with the influence of laboratory management on students' performance.

Based on the lived experiences of the students, this study discloses that the well-equipped laboratory increased the students' performances whereas the deficiency of equipment in the laboratory provided no benefit to the students' performances in physics among the students of undergraduate level in the school of engineering. Also, the study revealed that the students' performances were found to be high in laboratories where safety measures are utilized whereas the performances were found to be lacking in laboratories having low - quality safety measures.

This study contributes significantly to the policy formulation and implementation in the colleges for the betterment of laboratory management in order to make students' learning prompt, reducing laboratory risk to the students. Also, this research provides a foundation for the scholars pursuing new research in the days to come.

Keywords: Engineering, Laboratory, Management, Performance, Nepal

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I. Introduction:

Physics, as a science, is crucial in explaining the events that occur within the universe. Physical rules and principles may be found in everything that happens around us. The field of physics has experienced several revolutions in the twentieth century. Considering material related to physics education in the laboratory, these academic methods allow for permanent learning alone or in groups. By exploiting laboratory approaches, students learn the way to use classroom learning rather than by processing it through cognitive means alone. Students increase their skills so as to grasp ideas at a higher level and apply them to their way of their life. This may help learns to build a positive attitude towards physics studies in addition to augmenting their skills and their techniques(Olufunke, 2012). The research laboratory may be a vital part of engineering students' education. Although several laboratory programs may fall short of those lofty goals, they must be exciting, enlightening, and fulfilling. Much has been printed about ways to improve physics laboratories for physics and science students, comparatively little has been written on improving these laboratories for engineering students(Kirkup et al., 1998). The extent to which engineering views of the role physics plays for engineering students were congruent with their own surprised the physicists on the laboratory development team, particularly once the remarks focused on engineer's realm of operation (i.e the "real world")(Kirkup et al., 1998). The discussions were largely centered on the research laboratory information for engineering students. Several of the responses were useful in elucidating the expectations of engineering lecturers and professionals. The traits that physics has were widely arranged by engineering professionals. Students ought to study in and about laboratories additionally because of the general significance of physics in engineering education. Our university places a robust stress on the notion of group action theory and observation in engineering careers. This should be enforced so as to suit the requirements of each lecturer and pupil. Laboratory practices in engineering classes, significantly in physics classes, are important for college students to develop skills and mental tools for use in experimental physics and knowledge processing. This also aids students' management of basic concepts, helps them to know the worth of observation and to differentiate between interference created in theory and what's discovered in practice (Bhathal, 2011).

Purpose of paper and background

Nepal adapted the multi-university concept in 1983. The idea of Pokhara University was conceived in 1986; however, it was established only in 1997 under the Pokhara University Act, 1997. The incumbent honorable Prime Minster and honorable Educational Minister of the Federal Democratic Republic of Nepal are the Chancellor and the Pro-chancellor respectively. It is a non-profit autonomous institution, partly funded by the government of Nepal and partly by revenues from its students and affiliated colleges. The School of Engineering (SOE) was established in 2009. At this moment, the school includes civil engineering, civil and rural engineering, electrical and electronics engineering, software engineering, computer engineering at the undergraduate level and construction management, structural engineering, hydropower engineering, public health and disaster engineering, electrical engineering in power systems at the graduate level. The purpose of this paper is to find out how engineering students perceived their physics lab work at the School of Engineering of Pokhara University. The method students are required to learn takes into account the authors' knowledge of human cognitive architecture, expert-novice difference and cognitive load (Jalil et al., 2020). The guided practice mode has been tailored for a physics practical to reap positive effects from study. Most of the laboratory manuals give comprehensible commands as to how the systems are to be set up and how to perform the experiment to achieve meaningful consequences for the analysis. This approach additionally ensures that scholars are capable of linking experimental facts with the hypothesis and they are less probable to make errors while deciphering information(Bhathal, 2011)

Objective of Research:

The main objectives of this research paper are:

1) To determine the efficiency and effectiveness of the university laboratory safety measures as well as the students' awareness of laboratory hazards in physics laboratories in Pokhara University.

2) To set up the mechanisms to ensure adequate, effective and efficient utilization of physics laboratory resources and the effect of these mechanisms on undergraduate engineering students' performance in physics.

3) To evaluate the challenges facing the university students in management of the physics laboratory.

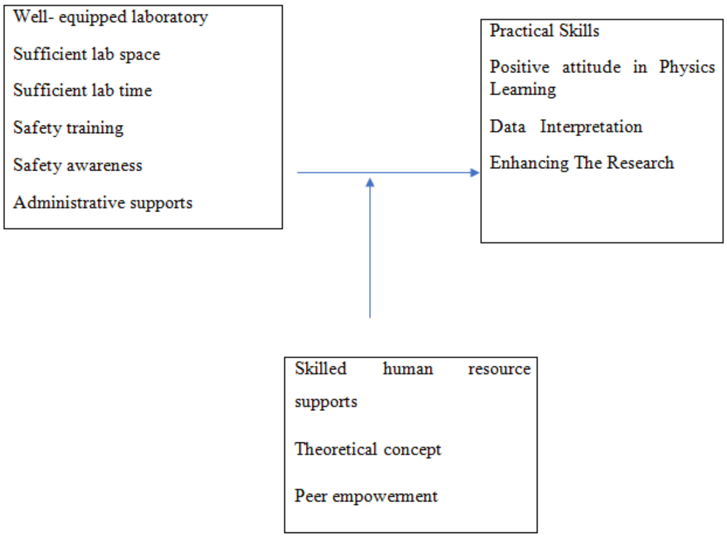
4) To develop strategies of improving laboratories' management that improve students' theoretical concepts of physics.

II. Literature Review:

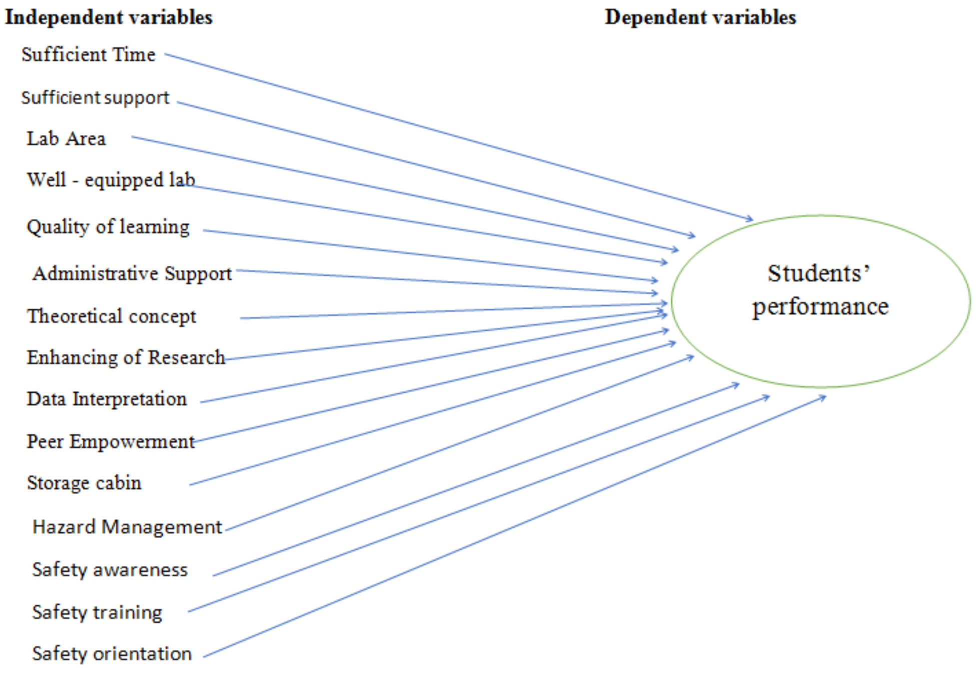
In this research, the authors have furthered understanding between those managing the science laboratory and students and those instructing them. Physics is the bedrock of science and technology, and, as a result of several tools and theories developed in the course of the progress of the science of physics, advancement in many fields have been made (Olufunke, 2012). Principles of physics have been widely used for various fields of engineering. It is accepted that science laboratory work gives scholars an opportunity to generate experimental and analytical ideas to correlate links between theories and observation. (Bhathal, 2011). This allows students to develop their ability to manipulate instruments, to perform experiments, and to gather knowledge. These techniques also allow for cooperative learning and to incorporate these analyses into their behavior. This laudable aim has been accepted by experimental physicists and engineers (Bhathal, 2011). Laboratory managers at the school level assume that first hand expertise in observation and manipulation develops understanding and appreciation. Laboratory coaching is additionally ofttimes accustomed to foster skills necessary for advanced study or research. The target considerations are the acquisition of adequate science laboratory resources and their effective utilization for student's performance in physics(Frank van Steenbergen & Tuinhof, 2009). The tutorial experience involving the learner's activated problems solving skills maintains knowledge acquisition longer than abstract experiences (Yousuf and national capital 2005). As for the place of learning, young physicists should have access to necessary data, materials and resources. They need to interact with tangible and intangible resources so as to ensure learner-centered activities are an integral part of learning science(Frank van Steenbergen & Tuinhof, 2009). Laboratories with inadequate materials have had an adverse effect on performance in science (Lal et al., 2017). In short, laboratory facility has a direct effect on their learning process. Most of the time, students fail to acquire laboratory skills because their studies were not conducted sensibly and effectively.(Dewey, 1906)

Conceptual Framework:

A conceptual framework is a model of presentation wherein a scientist gestates or represents the link between variables within the study and shows the relationship graphically (Fig.1) that shows the interaction between the laboratory management practices. and learning outcome.



The diagram of laboratory management makes up important variables in students' performance. Laboratory management includes equipping the lab well, making certain the lab is utilized in an acceptable way, effective direction by skilled personnel, laboratory organization and making certain safety procedures are followed in laboratories. A great deal of the literature supports the idea that students' performance in physics may be a result of effective lab management. The study has an analog in Production Function Theory (Bateman et al., 2014) often used to measure commercial material production. "Potency" is used to describe the amount of effort needed to accomplish a job or do some work. "Productivity" is used to express a firms work done in a given length of time. For this model, education is understood to be a production with learning as its outputs. The inputs work done by teaching and non-teaching staff, materials for teaching learning, and buildings (science laboratory area). The output is the learning created by pedagogy, the sharing of knowledge and skills additionally measured by the graduation of scholars.



Limitations of the Study

1. This study is confined to 200 undergraduate engineering students of the academic year 2016-2021.
2. As opinions may vary tremendously, this research has considered only the respondents' answer.

Limitations of the Study

1. Sample of the research represents the population
2. The higher percentages of responses from respondents show the positive opinions regarding physics lessons and physical experiments.

III. Research Design and Methodology

This research paper was designed using the descriptive survey method. These studies are concerned with describing characteristics particular to individuals or groups. Descriptive research is a process of collecting data in order to test a hypothesis or to answer questions concerning the current status of the objective of the study. It is helpful in collecting the quantitative data based on individual knowledge, perceptions, feelings and opinion

Area of Study

The study was carried out in School of Engineering (SOE) at Pokhara University, Nepal. It is about 180 km west from the capital city of Nepal, Kathmandu.

Target population

The target population is undergraduate engineering students from the School of Engineering (SOE) for the academic years 2016-2021.

Sampling Technique and Sample size:

The sample size is small due to the COVID-19 pandemic, limitation of time, funds and lack of human capital. However, the study was carried out from a carefully selected sample to represent the entire population of undergraduate engineering students of the academic years selected. The data was able to cover nearly 30 % of engineering undergraduate students of the SOE. The sample size for a small population of at least 20% is a good representation while 10% is good enough for a population of a larger size (Kumar, 2010). Random sampling was used to collect the data, The primary data and information was taken by questionnaires. The data which were not able to be collected physically were collected via google forms, an internet survey application. The data were represented in various units and forms depending on its nature to conducts through analysis using the SPSS-25 tool to fulfil the set of objectives. The researcher uses the questionnaire to obtain more precise information in a structured framework. A questionnaire is a research tool that can be used to collect data about a large group of subjects within a short time interval. It also allows the researcher to collect larger amounts of data in a relatively short amount of time (Gay et.al, 2009)

Method of data Analysis
Data analysis_is a process of inspecting, transforming and modelling data with the objective of highlighting useful information, suggesting conclusions and supporting decision makers (Orodtho,et al, 2012). The SPSS-25 software was used to analyse data qualitatively and quantitatively.

IV. Results and Discussion:

The authors obtained the results from the software mentioned above. Although the statistical analysis was conducted using frequency data, mean and variance, the results have been categorized in the table below and expressed in percentage. Actually, responses obtained as "Yes" or "No" questions were to 1 and 0 respectively. These were translated to the nominal scale and added in the SPSS-25 tool.

The analysis of the data presented in the Appendix I reveals that the learning of theoretical concepts, cooperation among friends working together had an identical mean value (84.31%), enhancing research and data interpretation shared a mean value (83.33%) safety training had a mean value of 76.47%, safety awareness had a value of 67.65%, quality of learning has mean value(62.75%) and safety training had a mean value 58.82%. On the other hand, other variables such as administrative support, skilled human resource support, sufficient lab time, hazard management, and a well-equipped lab had values of 40.59%, 32.35%, 25.49%, 23.53% and 13.73% respectively. Also, it has been noted from the analysis that the variables administrative support, skilled human resource support, sufficient lab time, hazard management and the presence of a well-equipped lab when considering the students' performance are below average.

V. Conclusion:

This study was able to establish that the students' performance was affected by the management of the laboratory for undergraduate engineering courses. A good laboratory has a positive influence on academic achievement using the learning by doing process. The statement of variables shows that there have been a few failures during laboratory management hence some students have negative attitudes toward the lab work. However, good laboratory management makes theoretical concepts (of physics) easy to learn. From this study, it could be said that good laboratory management play a crucial role in their performance.

1. It would behoove the administration to pay more attention to arranging a well-equipped laboratory, and these are best to be inspected regularly.
2. More human resources are to be devoted to safety orientation, hazard management and maintenance of the storage cabinet, as they directly influence a students' physics learning process.
3. A higher priority on good management of the physics lab in order to improve the students' performance during physics courses is good policy.

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Appendix: I

Sufficient Lab Time

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	76	74.5	74.5	74.5

		Frequency	Percent	Valid Percent	Cumulative Percent
	Yes	26	25.5	25.5	100.0
	Total	102	100.0	100.0	

Skill Human Resource Support

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	69	67.6	67.6	67.6
	Yes	33	32.4	32.4	100.0
	Total	102	100.0	100.0	

Laboratory Area

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	76	74.5	75.2	75.2
	Yes	25	24.5	24.8	100.0
	Total	101	99.0	100.0	
Missing	System	1	1.0		
Total		102	100.0		

Well-Equipped Lab

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	88	86.3	86.3	86.3
	Yes	14	13.7	13.7	100.0
	Total	102	100.0	100.0	

Quality Learning

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	38	37.3	37.3	37.3
	Yes	64	62.7	62.7	100.0
	Total	102	100.0	100.0	

Safety Training

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	24	23.5	23.5	23.5
	Yes	78	76.5	76.5	100.0
	Total	102	100.0	100.0	

Administrative Support

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	60	58.8	59.4	59.4
	Yes	41	40.2	40.6	100.0
	Total	101	99.0	100.0	

Missing	System	1	1.0		
Total		102	100.0		

Theoretical Concept

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	16	15.7	15.7	15.7
	Yes	86	84.3	84.3	100.0
	Total	102	100.0	100.0	

Enhancement of Research

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	17	16.7	16.7	16.7
	Yes	85	83.3	83.3	100.0
	Total	102	100.0	100.0	

Interpretating of Data

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	17	16.7	16.7	16.7
	Yes	85	83.3	83.3	100.0
	Total	102	100.0	100.0	

Peer Empowerment

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	16	15.7	15.7	15.7
	Yes	86	84.3	84.3	100.0
	Total	102	100.0	100.0	

Safety Awareness

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	33	32.4	32.4	32.4
	Yes	69	67.6	67.6	100.0
	Total	102	100.0	100.0	

Lab Hazard Management

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	78	76.5	76.5	76.5
	Yes	24	23.5	23.5	100.0
	Total	102	100.0	100.0	

Storage Cabinet

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	77	75.5	75.5	75.5
	Yes	25	24.5	24.5	100.0
	Total	102	100.0	100.0	

Safety Orientation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	42	41.2	41.2	41.2
	Yes	60	58.8	58.8	100.0
	Total	102	100.0	100.0	

Safety Training

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	24	23.5	23.5	23.5
	Yes	78	76.5	76.5	100.0
	Total	102	100.0	100.0	

Table for mean value and variance of variables.

S.No.	Name of variables	Mean value in %	Variance in %
1	Theoretical concept	84.31	13.4
2	Peer empowerment	84.31	13.4
3	Enhancement of Research	83.33	14
4	Interpretation of data	83.33	14
5	Safety Training	76.47	18.2
6	Safety awareness	67.65	22
7	Quality of learning	62.75	23.6
8	Safety orientation	58.82	24.5
9	Administrative support	40.59	24.4
10	Skill human resource support	32.35	22.1
12	Sufficient time in Lab	25.49	19.2
13	Lab hazard management	23.53	18.2
14	Storage cabinet in lab	24.51	18.7
15	Well-equipped lab	13.73	12.0