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An Analysis of Laboratory Skills Among University Science Students

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ABSTRACT

Laboratory skills form an essential component of science education, fostering practical understanding and critical thinking among university students. This research undertakes a comprehensive analysis of laboratory skills among university students in Bahawalpur, aiming to assess their proficiency and attitudes towards practical science education. The research is conducted to find out the significance of laboratory skills among university students. The study gathers by quantitative data to provide a holistic understanding of the subject. The population for this study comprises university students enrolled in science-related disciplines in selected university students in Bahawalpur. The study's participants were departments of science including physics, chemistry, biology, zoology, and computer science. This study involved a random sampling. Sampling was comprised of appropriate University of District Bahawalpur. This study involved a sample randomly selected 300 science students from various universities of Bahawalpur. The research finding evaluate the laboratory skills of these students, providing insights into their perceptions, attitudes, and experiences. Additionally, it shed light on students' mastery of analytical skills, safety measures, and their capacity to communicate scientific findings effectively.

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1. Introduction

The notion of a laboratory holds multifaceted interpretations across scholarly discourse. Scholars have offered diverse insights into the significance and essence of laboratories within the educational context. According to Aikenhead (1988), the university laboratory emerges as a pivotal space where science students engage in hands-on experiments, thereby fostering a deeper understanding of scientific principles. This experiential approach aligns with the transformative process of active learning, empowering students to bridge theoretical concepts with practical applications. This is essential for cultivating not only their scientific proficiency but also their critical thinking and problem-solving abilities. Maduabum's perspective underscores the centrality of laboratory skills in shaping university students into adept practitioners of scientific knowledge acquisition. Furthermore, Jones and Patel (2019) accentuates the university laboratory's role as a controlled environment where students partake in scientific investigations, thereby expanding their comprehension of subject matter. The laboratory becomes not only a space of exploration but also a repository of scientific tools, materials, and apparatuses, enabling students to engage with the tangible tools of their chosen fields. Such an environment cultivates a sense of curiosity, nurtures experimental inquiry, and lays the foundation for students to develop sophisticated laboratory skills.

Abrahams (2007) comprehensive perspective on laboratory spaces encompasses both outdoor settings and well-equipped indoor facilities. Irrespective of the physical domain, Igwe highlights the paramount importance of a uniform laboratory experience for all university students. This inclusive approach resonates with the principle of democratizing access to experiential learning, ensuring that each student is empowered to engage in a spectrum of experimental, observational, and demonstrative activities. This holistic engagement within laboratory settings culminates in a deepened understanding of theoretical concepts through practical exploration. Aligned with these notions, Aikenhead and Elliott (2010) posits that the university laboratory serves as a specialized arena crafted for conducting practical and experimental research. This notion is integral within higher education, where laboratories are intrinsic components of a robust scientific curriculum. Such laboratories provide a platform for students to not only consolidate their theoretical knowledge but also to cultivate skills that resonate with the broader objectives of scientific literacy. These laboratory skills, developed through hands-on experiences, are pivotal for preparing students to navigate the complexities of real-world scientific challenges.

Underscoring the significance of laboratories, Garcia et al. (2018) accentuates their indispensability for effective science education within the university sphere. Laboratories are catalysts that foster active participation, enabling students to engage with the intricacies of scientific processes firsthand. The acquisition of laboratory skills is fundamental for university students, equipping them with the ability to apply theoretical insights to practical scenarios and ensuring a comprehensive understanding of their chosen disciplines. As we embark on a journey to explore the realm of laboratory skills within the context of university education, this research endeavors to elucidate the diverse dimensions of laboratory skills, their implications for students' scientific competence, and the strategies for enhancing their effectiveness.

1.1. Statement of the Problem

The statement of the problem was, "An analysis about Laboratory Skills of University Students in Bahawalpur" The current status of laboratory skills among university students in Bahawalpur remains an essential yet underexplored area in science education. This study aims to analyze the existing levels of laboratory skills, identify challenges faced, and assess the impact of teaching methodologies. Addressing this gap will provide insights into enhancing laboratory skill development strategies, ensuring that students are adequately equipped for practical application and critical thinking in their academic pursuits and future careers.

1.2. Objectives of the study

- To examine Laboratory skills among university students.
- To assess the current levels of laboratory skills among university student.
- To explore the existing Laboratory Skills among University students.
- To propose recommendations for enhancing laboratory skill development among university students.

1.3. Significance of the Study

This study would be useful to:

- University teachers in selecting appropriate strategies to develop laboratory skills among university students.
- By this university students to involve their laboratory skills by conducting practical's, under the supervision of their teachers.
- Addressing the critical need for enhancing laboratory skills among university students.
- University Head teachers provide necessary facilities for practical in the university.
- University curriculum developer helps to develop the syllabus of practical.

2. Review of Related Literature

Numerous researchers have observed that teachers often exhibit surprise when asked about the significance of laboratory skills in school science (e.g. Lin (2007). It appears that laboratory skills have evolved into a customary element of science education in English educational settings, to the extent that educators rarely question their instructional presence. As Liu, Hu, Jiannong, and Adey (2010) have noted, teachers express uncertainty regarding the role and purpose of examinations linked to the Science National Curriculum. This uncertainty in the demonstration of laboratory skills by teachers might stem from their limited contemplation of the underlying reasons. This lack of comprehension also casts doubt on the reliability of their attitudes towards assessments aligned with the objectives of laboratory skills. Parkinson (2004) elucidates that a range of factors, spanning personal to societal, operating within school contexts contribute to the shaping of educators' attitudes toward laboratory skills. As per a study by I. Abrahams and Saglam (2010), recent the attitudes of contemporary educators towards laboratory skills exhibit minimal shifts compared to those prevalent in the twentieth century, as earlier identified by Kerr in 1963. Moreover, the study by Swain, Monk, and Johnson (2000) unearthed a consistent attitude toward laboratory skills over 35 years. I. Abrahams and Saglam (2010) infer that the perception of reduced competition among different topics might account for this consistency, although such patterns might not necessarily apply across all Key Stages. Bennett, Roman, Arnold, Kay, and Goldenhar (2005) further elucidates that the points under consideration can be connected and amalgamated in diverse configurations.

Abrahams and Saglam (2010) uncovered that the attitudes of educators at Key Stage 5 (A-levels) signify the necessity to "render science authentic and relevant to sustain interest in a subject that is considerably more intellectually demanding than at Key Stage 4" (p. 12). While there is an element of ambiguity within this perspective, it could prove pivotal in motivating students to pursue science post-secondary education, indicating that aspects related to scientific skills might hold lesser relevance in the teaching of laboratory skills at this level. An educator's commentary within the study reflects this sentiment: "If they don't know how to do it when they're doing 'A' level [Key Stage 5], they shouldn't be doing 'A' level physics" (p. 12). This suggests educators' enthusiasm to engage students to continue with science. Nevertheless, one could argue that at an advanced level, students should possess the intrinsic motivation to study the subject, rather than relying on external teacher-driven incentives, as might be required at Key Stage 4 (Millar & Abrahams, 2009). Contrary to Swain et al. (2000), I. Abrahams and Saglam (2010) did not identify shifts in educational and societal settings contributing to changes in educator attitudes. Instead, I. Abrahams and Saglam (2010) found that "changes in the environment can induce alterations in pedagogy if those changes exert pressure on (or relieve it from) educators" (p. 13, italics in the original). According to Yung (2006) research, educators' perspectives on the value of laboratory skills in education stem from their interpretation of "fairness" in education.

There exists a considerable body of research examining students' overall attitudes toward science (Lakshmi, 2004). However, there seems to be a notable gap in research focusing specifically on students' perspectives regarding laboratory skills. Despite teachers often highlighting the importance of laboratory skills, it remains crucial to inquire into students' sentiments about these skills. While teachers emphasize laboratory skills, we must also understand students' feelings towards them, including whether they find these skills engaging and if they influence their decisions to pursue science further (Malone & Cavanagh, 1997). Lakshmi (2004) highlighted those Key Stage 4 students valued social interaction during laboratory work, while Bennett et al. (2005) stressed the need for students to connect with their peers during this process. Assuming the role of a researcher seemed to aid students' comprehension (Ajzen, 2005), but this also required a strong foundation of scientific concepts (Hart, Mulhall, Berry, Loughran, & Gunstone, 2000). Students' interests and abilities also played a role in their engagement with laboratory skills (Ajzen, 2005). Despite varying opinions, students' attitudes toward laboratory skills didn't significantly change over time (Swain et al., 2000). However, the integration of laboratory skills may not consistently translate into effective learning (Wellington & Ireson, 2002). Notably, the usage of laboratory skills might need to be tailored based on learning outcomes (Lakshmi, 2004). Albarracín, Johnson, and Zanna (2014) research showed that students' attitudes depended on their perception of fairness in teaching. Laboratory skills should contribute to student engagement and understanding rather than solely fulfilling practical exam requirements (Millar & Abrahams, 2009). Recent studies found that students' attitudes towards laboratory skills slightly decreased from Year 7 to Year 9, indicating potential dissatisfaction due to limited exposure to engaging science experiences (Barmby, Kind, & Jones, 2008). Although students expressed a preference for laboratory work over other learning methods, there remains room to investigate the factors behind their perceived decline in attitudes (Millar & Abrahams, 2009). To comprehensively understand students' claims of interest and enjoyment of laboratory skills, further research is needed to explore their motivations and decisions regarding the pursuit of science post-graduation (Barmby et al., 2008).

3. Research Methodology

3.1. Design of the Study

A quantitative research method was employed in the research. Questionnaires were adopted to collect the quantitative data to examine the purpose.

3.2. Population of the Study

This study focused on selected universities located in District Bahawalpur as the target population. The population of the study comprised GSCWU and IUB. The overall population under consideration numbered 51,746 individuals. Specifically, the research encompassed diverse science departments such as Physics, Chemistry, Biology, Zoology, and Computer Science within Govt. Sadiq College Women and Islamia University in District Bahawalpur.

3.3. Sample Size

Given the extensive and geographically dispersed nature of the study population, comprising a total of 51,746 individuals within Govt. Sadiq College Women University (GSCWU) and Islamia University Bahawalpur (IUB), a representative sample was deemed appropriate. The research focused on the Bahawalpur district to select a convenient sample of 300 students from Govt. Sadiq College Women’s University Bahawalpur and Islamia University Bahawalpur.

3.4. Research tool

The primary data collection for this research was facilitated through a questionnaire. The participants of the study were students. The decision to focus on District Bahawalpur was strategic, as it allowed for the implementation of a random sampling technique that aligned with the study's objectives. Researcher used close ended questions as a research tool. A commonly employed method in survey research. Considering practical constraints such as time limitations, a random sampling approach was adopted for data collection. Drawing insights from the existing literature, the questionnaire was tailored to align with the study's goals. To ensure accuracy and consistency, the author personally administered the questionnaire by conducting face-to-face interactions with the respondents.

Table 1: Structure of the Questionnaire

Sr. No.	Statement
1	Students manage equipment and chemicals well.
2	Students arrive in lab on time for experiment.
3	Students do experiments full-time in lab.
4	Complete their experiment on schedule.
5	Students clean and store equipment after experiments.
6	Students can schedule theoretical work.
7	Students can do experiments on time.
8	Time for each practical session was sufficient.
9	Students practice safety in lab.
10	Working in a lab interests student.
11	Students do control lab experiments.

12	Students complete lab work on time.
13	Students separate organic substances.
14	Students can calculate readings.
15	Students know observation procedures.
16	Students can record thermometer readings.
17	Students understand reading calculations
18	Students can quantify the sample.
19	Expert in analysis.
20	Students fully comprehend reading and observation analysis.
21	Lab work is fun for students.
22	Students evaluate readings enough.
23	Student conclusions can be based on evidence and logic.
24	Students can understand relationships.
25	Students understand instrument precision.
26	Final findings are concluded by students.
27	Students can demonstrate experiments individually and in groups.
28	Every class with a presentation would be interesting.
29	Practical demonstrations helped pupils focus.
30	Students need examples to grasp.
31	Students learned more from practical examples.
32	Practical demonstrations exhaust pupils and decrease interest.
33	Students can pair results.
34	A learner can distinguish two compounds by certain tests using discretion.
35	Students can work alone in lab.
36	Students can explain their practical task.
37	Student understands experimentation.
38	Students stay patient if long work yields little returns.
39	Lab and practical maintenance is crucial.
40	Students wear lab coats and shoes.
41	Lab students prioritized numerous tasks.
42	Students can solve lab problems using problem-solving abilities.
43	I worked well with lab-mates to attain research aims.
44	I effectively explained scientific concepts or experimental results to varied lab audiences.
45	Science labs let students try experiments.
46	I handled lab team issues well.
47	I stayed calm amid stressful lab experiments.
48	Helps create an artificial atmosphere.
49	I helped your lab-mate, showing collaboration.
50	I adapt to new lab procedures and technologies.
51	I settled lab disputes.
52	It helps investigate human cells, fluids, tissue, and organs.
53	I managed big lab data sets.
54	When lab supervisors or mentors instruct me, I listen actively.
55	I can teach students and junior lab members lab skills.
56	Multiple variable and condition lab experiments were my responsibility.
57	I effectively presented lab or study results.

3.5. Data Collection

In the pursuit of data collection, the researcher personally visited chosen universities within District Bahawalpur. During these visits, a well-structured questionnaire was administered to a sample of 300 students. The valuable insights garnered from the responses of these 300 questionnaires were subsequently integrated into our research analysis. The data collection method employed in this study is a structured survey questionnaire. The questionnaire is designed to assess participants' attitudes and perceptions regarding laboratory skills. The questions are formulated using Likert-scale items to enable participants to provide their responses on a predetermined scale that ranges from strongly agree to strongly disagree.

3.6. Data Analysis Techniques

The analysis of data collected through the survey questionnaire involves both descriptive statistics and mean calculations. Descriptive statistics, including frequencies and percentages, provide a clear overview of participants' responses to each item. Mean calculations help identify the average opinion or attitude of participants towards laboratory skills. This statistical approach offers a quantitative insight into the distribution of responses. For calculating various responses, frequencies were multiplied, and distinct options were assigned numerical values to ascertain mean scores accurately. Strongly Disagree, Disagree, Undecided, Agree, Strongly Agree. Results were manipulated for finding based on data analysis.

Less than half of the majority (48%) of respondents agreed that students can handle apparatus and chemicals properly. Half of the majority (54%) of respondents agreed that students reach the lab on time. Half of the majority (56%) agreed that students spend their full time in the lab to complete experiments. Half of the majority (59%) believed that students perform their experiments in the allotted time. Half of the majority (60%) agreed that students wash apparatus after completing experiments and keep them on proper shelves. Half of the majority (62%) believed that students can manage time for theoretical work. Half of the majority (61%) agreed that students can perform experiments within the given time. Half of the majority (60%) felt that the time allocated for practical sessions was sufficient. Half of the majority (61%) agreed that students practice safety measures in the laboratory. Half of the majority (63%) agreed that students are interested in working in the lab. The Majority (65%) believed that students perform experiments in a controlled environment. Half of the majority (60%) agreed that students are regular and punctual in the lab. Less than half of the majority (57%) agreed that students are able to separate organic compounds. Less than half of the majority (56%) agreed that students are knowledgeable about calculating readings.

Less than half of the majority (58%) agreed that students are aware of observation techniques. Majority (64%) believed that students know how to note readings from a thermometer. Majority (62%) believed that students know about calculations of readings. Majority (64%) believed that students can calculate mass by spectrometry. Half of the majority (60%) agreed that students can calculate given samples quantitatively. Majority (59%) believed that students have a full grip on the analysis of readings and observations. Majority (69%) agreed that students find pleasure in working in the lab. Majority (59%) believed that students have enough judgment about readings. Majority (61%) agreed that students can reach conclusions based on evidence and reasoning. Majority (59%) believed that students can develop relationships among things. Majority (62%) believed that students are knowledgeable about the precision of instruments. Majority (68%) believed that students could conclude the final results. Majority (63%) agreed that students can demonstrate experiments individually as well as in groups. Majority (65%) believed that having a demonstration in every lesson would be interesting. Majority (69%) believed that practical demonstrations help students focus their attention. Less than half of the majority (53%) agreed that students cannot understand material without demonstrations. Majority (61%) believed that practical demonstrations enhance students' learning. Less than half of the majority (57%) agreed that demonstrations make students tired, and they show less interest. Majority (62%) believed that students can arrange or match things into pairs. Majority (64%) believed that students can differentiate between two chemicals by specific tests. Less than half of the majority (57%) agreed that students are able to work in the lab separately. Majority (64%) believed that students can elaborate on the task of a practical given to them. Majority (62%) believed that students know experimentation. Less than half of the majority (57%) agreed that students remain patient if work is prolonged and results are not achieved. Majority (65%) believed that maintenance of the lab and practical is essential. Majority (62%) believed that students wear lab coats and suitable footwear.

Majority (65%) believed that students prioritize multiple tasks in the laboratory. Majority (64%) believed that students can utilize problem-solving skills to overcome technical issues. Majority (61%) believed that students can effectively collaborate with others to achieve common research goals. Majority (68%) believed that students can communicate scientific concepts or experimental results effectively. Majority (68%) believed that a science lab provides hands-on experience. Majority (66%) believed that students effectively manage conflicts within a laboratory team. Majority (66%) believed that students manage their emotions and maintain composure during high-pressure laboratory experiments. Majority (69%) believed that the lab helps create an artificial environment. Majority (67%) believed that students demonstrate teamwork skills. Majority (66%) believed that students show adaptability in learning new laboratory techniques or technologies. Majority (68%) believed that students can successfully resolve conflicts between laboratory members. Majority (67%) believed that the lab facilitates the study of cells, fluids, tissue, and organs. Majority (67%) believed that students can effectively manage a large amount of data. Majority (70%) believed that students exhibit active listening skills. Majority (73%) believed that students can train other students or junior lab members. Majority (73%) believed that students can manage complex laboratory experiments involving multiple variables and conditions. A Significant majority (82%) believed that students can present laboratory findings or research outcomes to audiences.

4. Conclusion

This section presents a comprehensive summary of the research findings based on the analysis of data collected through the survey conducted among university students in Bahawalpur. The research aimed to explore and evaluate the laboratory skills of these students, providing insights into their perceptions, attitudes, and experiences toward practical science education. The analysis encompassed a wide array of parameters, ranging from handling apparatus and chemicals to collaborating within laboratory teams. The data collected through the survey unveiled students' perspectives on practical sessions, emphasizing their ability to manage time, perform experiments, and comprehend scientific concepts. Additionally, it sheds light on students' mastery of analytical skills, safety measures, and their capacity to communicate scientific findings effectively. The study employs a quantitative research design. It was a descriptive type of research and a survey method was used to collect data. A questionnaire was constructed to collect data from university students. The study's participants were departments of science. Random sampling is used to collect the data from university students. The researchers used firsthand information. Students served as the study's respondents. A structured survey questionnaire is developed to assess laboratory skills. The questionnaire includes Likert-scale questions, close-ended items. The survey gathers data on participant’s self-assessment of laboratory skills, experiences, and challenges. Data analysis was done using an SPSS spread sheet. Descriptive statistics, including frequencies, percentages, and means, will be employed to analyze quantitative data.

4.1. Recommendations

Based on the findings of this research, several recommendations can be put forth to further enhance the effectiveness of laboratory education for university students:

- Institutes should emphasize hands-on training and real-world applications in laboratory sessions to bridge the gap between theoretical knowledge and practical skills.
- Institutes should prioritize educating students about safety measures in laboratory settings to minimize the risks associated with experimentation.
- Encouraging collaborative projects and group experiments can foster teamwork skills and the sharing of diverse perspectives.
- Continuous professional development programs for instructors can ensure that they are well-equipped to provide high-quality laboratory instruction.
- Incorporating modern tools and technology in laboratory experiments can enhance students' exposure to advanced techniques.

4.2. Implications for Future Research

While this research contributes significant insights into the laboratory skills and attitudes of university students in Bahawalpur, it also paves the way for future studies. Further research could delve into the impact of different teaching methodologies on laboratory skill development, explore the role of socioeconomic factors, and examine the effectiveness of interdisciplinary approaches in practical science education.

In conclusion, this study offers a valuable perspective on the laboratory skills and attitudes of university students in Bahawalpur. The findings underscore the importance of practical education and highlight the positive outlook of students towards laboratory work. The recommendations provided aim to enhance the quality of practical science education, ensuring that students are better prepared to excel in scientific pursuits and contribute effectively to the field.

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