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# UTILITY OF SCIENCE LABORATORIES: AN ANALYSIS OF SECONDARY SCHOOL STUDENTS' PERCEPTIONS

***Dr. Hafiz Muhammad Arshad, **Dr. Khalid Saleem, ***Muhammad Sajid**

*Department of Teacher Education, University of Okara
**Department of Teacher Education, University of Okara
***M.Phil Scholar, Department of Educational Research & Assessment, University of Okara

***ABSTRACT:***

*This study was designed to analyze students' perceptions about the facility of science labs in public sector schools at the secondary level. The study was conducted in two schools in the district of Okara and two schools in the district of Kasur. The study examined the students' perceptions about the availability of science lab, availability of science lab equipment, use of equipment, lack of practical work, condition of science lab, infrastructure of science labs, the role of science teachers and how practical work influences on students' achievements in science subjects. Various research studies highlight that students' performance in science subjects could be better in public sector schools due to insufficient science lab work. To complete the study, a survey research design was used; a quantitative research approach was used to collect data using a 5-point Likert scale questionnaire. The study sample was two urban (one male and one female) and two rural (one male and one female) schools from one district, and the same sampling procedure was applied in the second district. From these two districts, eight schools and 100 students were selected. The data was analyzed using SPSS version 20, and one sample t-test and an independent t-test were applied. The findings of this study revealed that in sampled schools, the teachers needed to give more importance to the lab work because labs needed more equipment. In sampled schools, the condition of the science lab could have been better with more lab space. Moreover, there is no science lab in one of the sampled schools. It was also found that there needed to be more science teachers. The teacher performed experiments, and students observed the teacher's actions. It was recommended that the government provide equipment in the schools according to the number of students so that all the students may perform experiments. The government should build science lab in those schools where science lab is absent. Moreover, the government should train teachers so that teachers understand the use of new technology.*

***Keywords:*** *Science Lab, Schools, Secondary*

## INTRODUCTION

Teaching and learning are interconnected from various aspects. It is said that effective teaching leads to effective learning by showing the strong bond between teaching and learning (Walter, 2015). In expository, inquiry and problem-solving methods, the results of the experiments are known. On the other hand, in the inquiry method, the results are not planned and generated independently. Doosti (2014) describe that most teachers use traditional teaching methods in the laboratory. In the traditional method, a teacher describes the topic under study. The teacher also relates it to previous work. Then, students repeat all the practical work phases by imitating what the teacher tells them in the lab. The inquiry method helps the students to construct their knowledge. He further explains that effective teaching depends on several factors, such as teaching methods, teaching skills, communication style, subject knowledge, etc. A student's learning also depends on several factors, such as intellectual ability, incentives, learners' interest and learning content (Doosti, 2014).

At the same time, it is also crucial that the equipment in science labs is accessible and that students are taught how to use it in science labs. However, my research experience and relevant studies have indicated that students complain of having limited freedom to use science labs in secondary schools in Punjab. Moreover, it has also been observed that schools follow a set pattern of practice work in which students perform a fixed number of practical works. There are many implicated of this limited access provided to students. This study explored to what extent the students are satisfied with the science lab facilities in terms of timing for practice work, teacher's skill to teach and conduct practical work, etc.

**Laboratory work:**

Hofstein (1982) and Tobin (1990) agree that practical work plays a central part in science education because learners' understanding is enhanced when they are involved in lab activities. However, Millar (2004) emphasizes students' lab skills and believes that lab work provides a chance for the students to learn lab skills, such as knowing how to work with lab equipment and inquiry skills. He further explains that lab work is an educational activity in which students observe phenomena and perform experiments. Lab work helps the students to learn new scientific concepts more effectively. Students understand theoretical and practical work in scientific phenomena, which is also very interesting. Lab study is helpful for students as they study in the lab. In addition, laboratory study enhances student analytical and logical thinking and increases student interest in science (Ottander & Grelsson, 2006). If students learn science through lab work, it has lots of advantages for the students. Teachers must be careful while designing the lab activity for the students. Science lab work will only be productive for both teacher and students if it is planned carefully by the teacher (Halai, 2008).

**The Formation of Public Secondary Schools:**

Students in secondary education are expected to learn, grow, and gain confidence. Secondary schools offer an excellent opportunity to achieve goals, making them valuable. According to the Primary Education Development Programme (PEDP), from 2002 to 2007, the number of students doubled, and these institutions could not meet their demands. The government and MOEVT collaborated on a Secondary Education Development Plan (SEDP). These schools aim to improve student education. Second, the government seeks to boost science education by developing secondary schools (Amir et al., 2020). Science was taught in secondary schools in the 1950s, according to Iqbal Mahmood (2000). Practical was taught in the 1970s. The Pakistani government changed its education strategy in 1972. This policy required secondary schools to teach science.

**Approaches of teaching and learning science in secondary schools:**

Science teaching is considered a skilful art. In teaching and learning science various methods and approaches are used for teaching and learning science in secondary. These approaches promote different aims and goals of lab work. One of the most popular approaches to learning science is the problem-solving approach. A problem-solving approach is a means to achieve many learning outcomes. Science students, in this approach, solve scientific problems systematically. In the demonstration approach, the teacher shows certain concepts and principles to the students. The teacher conveys one idea at a time in a demonstration because multiple ideas may confuse the

students. It is more efficient because it takes less time than problem-solving, inquiry and laboratory methods (Mangel, 1995). In the laboratory approach, students perform lab experiments in groups and individually under their teacher's supervision. It also enhances many skills and scientific attitudes among the students.

**The role of lab works in teaching and learning of science subjects:**

School lab work is described as the practical activities performed in a controlled lab environment using different equipment. For the learning of science subjects, lab work plays a vital role because the significant goal at the secondary level is to develop experiment skills among the students (Carnduff & Reid, 2003). Science subjects are different from other subjects. The syllabus of science subjects includes a portion of practical work that has to be completed during a semester. In practical/ lab work, the student follows the scientific method. The scientific method includes identifying the problem, data collection, measurements, data analysis, prediction and conclusion, etc. In teaching and learning, science lab work plays an important role. During the lab work, students acquire many scientific skills, including critical thinking, collaboration, leadership, curiosity, etc. However, achieving these skills depends on how lab work is organized. Lab work is included in the curriculum at the secondary level, and it is also included in the final examination. Lab work does not mean performing tasks in the lab, but it helps to communicate information and ideas about the natural world (Abrahams & Millar, 2008).

**Practical sciences in secondary schools:**

Labs serve as a bridge between theoretical knowledge and practical application. To maximize their effectiveness, science labs in secondary schools should be well-equipped and not overcrowded (Tenaw, 2015). While teachers acknowledge the numerous benefits of science labs, students often need more opportunities to utilize them (Hunde & Tegegne, 2010). In many schools, lab activities are often constrained by a rigid, cookbook-style approach, limiting students' scope for exploration (Doosti, 2014). To enhance the quality of science education, schools need to invest in modern lab supplies and equipment, as a well-equipped science lab can significantly benefit students in various scientific disciplines (Doosti, 2014). However, in Pakistani schools, a shortage of resources, including limited time for experiments, inadequately trained science teachers, and a curriculum emphasizing rote memorization, poses substantial challenges to delivering effective science education (Al-Madani, 2004). Unfortunately, many public schools lack science labs, forcing teachers to use lecture-based instruction. Sometimes, teachers improvise experiments using readily available household materials, with students observing the teacher's demonstrations (Millar, 2004).

**Science laboratory teaching in developing countries:**

Science education is considered the key of development for the developing countries. In developing countries, science subjects are taught by lecture method, and students learn by rote memorization. For science experiments, almost 20% of teaching time is allocated because of a need for more equipment (AHDD, 2007). In Kenya, Wachanga and Mwangwi (2004) found that student-centred teaching methods enhance student learning and improve student achievement in which students participate actively in class activities. On the other hand, in teacher-centred methods, students need help understanding science concepts. However, in Pakistan, the

government and teachers should address the importance of science labs. This negligence affects the students' future.

**Current situation of science lab in Pakistan:**

After considerable effort, Pakistan moved toward improvement in the education system and literacy rate. According to a survey by the World Bank (2007), the literacy rate in Pakistan has increased up to 50%. Successive government tries to improve in the field of science and technology in Pakistan, but the government needs help to achieve the goal. The government of Pakistan spends hardly 2% of its GDP on education, which is the primary reason for its failure to achieve this goal. In the Pakistani education system, science is taught from grades 1 to 10, but the appropriate use of science labs needs to be addressed (Dilshad et al., 2020). Dilshad (2020) further explains that in Pakistan, the importance of science lab work is mainly neglected by the teachers and science subjects are taught theoretically in public sector schools. The main reason for the negligence of science lab work is that there needs to be a proper science lab and more lab equipment.

**Research Methodology**

This research study aimed to investigate students' perceptions of science lab facilities. It was based on the premise that students naturally possess curiosity and a penchant for inquiry, similar to scientists. The study emphasized inquiry-based science teaching methods and their impact on teacher performance and student learning, highlighting the importance of hands-on experiments for effective learning. The research design involved a quantitative approach, using a close-ended questionnaire to gauge student perceptions. The questionnaire was structured, offering multiple options for respondents to choose from. The target population comprised secondary-level students in rural and urban public schools, with a sample size of 150 students (50 each in biology, physics, and chemistry). Convenient sampling was employed due to its cost-effectiveness and resource efficiency, selecting eight public schools (4 urban and four rural) from the districts of Kasur and Okara. This study emphasized the importance of science laboratory facilities and the benefits of hands-on learning in scientific subjects.

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Vol.8 No.1 2024

**Results and Findings**

***Status of lab facilities***

One-Sample Statistics

| Variable | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|
| Students' perceptions of science lab | 100 | 2.7875 | .2164 | .0216 |

One-Sample Test

| | Test Value = 3 | | | | | |
|---|---|---|---|---|---|---|
| | T | Df | Sig. (2tailed) | Mean Difference | 95% Confidence Interval of the Difference | |
| | | | | | Lower | Upper |
| Students' perceptions of science lab | -9.817 | 99 | .000 | -.2125 | -.2555 | -.1696 |

The table above reflects a significant difference (.000 < 0.05) in the calculated and observed mean values. The mean value is relatively more significant than the test value (2.78 < 3).

ISSN Online : 2709-4030
ISSN Print : 2709-4022
Vol.8 No.1 2024

***Status of lab facilities according to "Resources"***

| One-Sample Statistics | | | | |
|---|---|---|---|---|
| Variable | N | Mean | Std. Deviation | Std. Error Mean |
| Resources | 100 | 3.4544 | .38004 | .03800 |

| One-Sample Test | | | | | | |
|---|---|---|---|---|---|---|
| | Test Value = 3 | | | | | |
| | T | Df | Sig. (2tailed) | Mean Difference | 95% Confidence Interval of the Difference | |
| | | | | | Lower | Upper |
| Resources | 11.958 | 99 | .000 | .4544 | .3790 | .5299 |

The table above reflects a significant difference (0.000 < 0.05) in the calculated and observed mean values. The observed mean value is relatively greater than the test value (3.45 >3).

***Status of lab facilities according to "Maintenance"***

| One-Sample Statistics | | | | |
|---|---|---|---|---|
| Variable | N | Mean | Std. Deviation | Std. Error Mean |
| Maintenance | 100 | 3.0243 | .4572 | .0457 |

| One-Sample Test | | | | | | |
|---|---|---|---|---|---|---|
| | Test Value = 3 | | | | | |
| | T | Df | Sig. (2tailed) | Mean Difference | 95% Confidence Interval of the Difference | |
| | | | | | Lower | Upper |
| Maintenance | .531 | 99 | .596 | .02429 | -.0664 | .1150 |

The table above reflects a significant difference (.596 < 0.05) in the calculated and observed mean values. The observed mean value exceeds the test value (3.02 > 3).

***Status of lab facilities according to "Teacher Skills"***

| One-Sample Statistics | | | | |
|---|---|---|---|---|
| Variable | N | Mean | Std. Deviation | Std. Error Mean |

| | | | | |
|---|---|---|---|---|
| Teacher Skills | 100 | 2.7520 | .6775 | .0677 |

| One-Sample Test | | | | | | |
|---|---|---|---|---|---|---|
| | Test Value = 3 | | | | | |
| | T | Df | Sig. (2tailed) | Mean Difference | 95% Confidence Interval of the Difference | |
| | | | | | Lower | Upper |
| Teacher Skills | -3.660 | 99 | .000 | -.2480 | -.3824 | -.1136 |

The table above reflects a significant difference (.000 <0.05) in the calculated and observed mean values. The observed mean value is relatively less than the test value (2.7520 < 3).

***Status of lab facilities according to "Opportunity of Learning for the Students"***

| One-Sample Statistics | | | | |
|---|---|---|---|---|
| Variable | N | Mean | Std. Deviation | Std. Error Mean |
| Opportunity of Learning for the Students | 100 | 3.2411 | .4461 | .04461 |

| One-Sample Test | | | | | | |
|---|---|---|---|---|---|---|
| | Test Value = 3 | | | | | |
| | T | Df | Sig. (2tailed) | Mean Difference | 95% Confidence Interval of the Difference | |
| | | | | | Lower | Upper |
| Opportunity of Learning for the Students | 5.404 | 99 | .000 | .2411 | .1526 | .3296 |

The table above reflects a significant difference (.000 < 0.05) in the calculated and observed mean values. The mean value is relatively more significant than the test value (3.24 > 3).

**Is there any significant difference in the lab facilities of male and female schools?**

The following results were found based on analyses.

***T-test for independent sample based on Lab Facilities***

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ISSN Print : 2709-4022
Vol.8 No.1 2024

| Variable | Gender | N | Mean | Std. Deviation | Df | t | p |
|---|---|---|---|---|---|---|---|
| Perceptions of students about science lab | Male | 38 | 2.744 | .2632 | 98 | .259 | .796 |
| | Female | 62 | 2.387 | .1846 | | | |

A T-test for Independent samples was run to check whether male and female secondary school students perceive science lab facilities similarly. Analysis in the above table reveals that no significant relationship existed in the perceptions of male and female students about the facility of a science lab in public sector secondary schools of Punjab (p=.796 > 0.05).

**Is there any significant difference in the lab facilities of urban and rural schools?**

The following results were found based on analyses.

***T-test for independent samples based on "lab facilities."***

| Variable | Location | N | Mean | Std. Deviation | df | t | p |
|---|---|---|---|---|---|---|---|
| Perceptions of students about science lab | Urban | 37 | 2.7910 | .2345 | 68.208 | .118 | .906 |
| | Rural | 63 | 2.7854 | .2070 | | | |

Analysis in the above table reveals that no significant relationship existed in the perceptions of urban and rural students about the facility of a science lab in public sector secondary schools of Punjab (p=.906 > 0.05).

The study's findings are based on data analysis results recorded as

1. Analysis shows that the overall status of lab facilities in the students' perceptions could be better. (M=2.7< 3). Students are not satisfied with the lab facilities.

2. Analysis shows that "Teachers Skills" (M=2.7<3) in the students' perceptions is poor.

3. Analysis shows that "Resources" (M=3.45>3), "Maintenance" (M=3.02 > 3) and "Opportunity of learning for the students" (M=3.2 > 3) in the students' perceptions are good.

4. There was no significant difference between "perceptions of students" (p=.796> 0.05) and "general questions" (p=.581 > 0.05). The x score for "perceptions of male students" (x= 2.74) is very close to the x score of female students (x= 2.38), and the x score for "General questions" of male students (x=1.47) is very close to the x score of female students (x= 1.46).

5. There was no significant difference between "Teachers skills" (p=.579 > 0.05) and "Opportunity of learning for the students" (p=.316> 0.05). The x score for "Teachers skills" of

urban schools (x=2.80) is very close to the x score of rural schools (x= 2.72), and the x score for "Opportunity of learning for the students" of urban schools (x= 3.18) is very close to the x score of rural schools (x= 3.27). (Table 4.17, 4.18)

**Discussion**

The study's goals were to a) assess student satisfaction with science lab facilities, b) identify students' problems during lab work, c) suggest ways to solve these problems and d) suggest ways for teachers to use lab time to teach science. This study found many interesting facts. Participants' perceptions suggest that majority of students are not satisfied with any of the aspects researched in this study. For example, they were found unsatisfied with Science facilities; they reported to have faced many issues regarding utilizing facilities in the science laboratories; they complained that they were not given ample time for laboratory work. The findings of present study are consistent with various findings of past studies. For example, Mercy (2015) found that schools have science rooms, not labs. In all sampled schools, equipment needed to be improved. The science lab was overcrowded during experiments. Improper arrangements of science laboratories have a negative impact on students learning as Halima (2015) found that poor science labs hurt student learning and academic performance. Schunk (2012) found that lab students observe nature. Positive results are frequently achieved if the teacher uses lab time well and gives students constructive feedback.

This study surfaced various issues connected with science laboratories which have been reported since long. Al-Madani (2004) believed that secondary school teachers undertake limited experiments due to time constraints. In Pakistan, school science labs need more capital. This shortcoming causes numerous other issues, including a lack of science teacher training, weak curriculum material, rote memorization in the exam system, and a lack of science teaching resources. Mafumiko (2006) and Kibga (2004) address limited scientific lab facilities. Student futures are affected by resource shortages. Halali (2008) states that Pakistani graduate students who become teachers need more critical thinking and scientific approaches. Thus, poorly trained students become terrible instructors, a cycle that persists in Pakistan.

Present study provided yet another opportunity to reiterate challenges that have been reported earlier. Dilshad (2020) noted that Pakistani teachers overlook scientific laboratory work and teach science theoretically at public schools. Lack of science lab space and equipment is the main reason for negligence. Lab work requires competent science professors, and the government needs to provide teaching opportunities. The government needs to introduce some mechanism to help rural science teachers and reform science laboratories to avoid wastage of public money and utilize it in an effective way to benefit students.

**Conclusion**

Present study is an attempt to highlight various issues regarding science laboratories facilities from students' perspective. The science curriculum required more experiments than students can actually perform. Male and female students receive identical lab facilities and face similar kind of issues. Lack of science lab supplies and big class size not only affect students' performance, it also prevents teachers from conducting sufficient experiments. Students in urban and rural areas

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Vol.8 No.1 2024

had similar lab facilities. Lab teachers are afraid to undertake experiments due to the severe teaching load.

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