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Perception of secondary schools' students about Physics practical work: Intended and enacted curriculum perspective

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ABSTRACT

The syntactic and pragmatic nature of science is learnt better through practical work. Practical work supports cognitive, neuromotor and attitudinal domains of learning through scientific reasoning. Laboratory apparatus availability, their functionality, usability and standard schedule in academic curricula are essential for smooth conduct of practical work. Teachers' perceptions about practical and students' scientific inquiry about practical work are linked with effective curriculum implementation. The current study was planned to examine the gap between intended curriculum and enacted national curriculum of physics focusing conduct of practical and the availability of laboratory apparatus. The study was descriptive in nature, following quantitative research design, and a survey method was used to frame the study. A multistage stratified random sampling technique was used to collect the data. Secondary school physics teachers, students, laboratory stock register and the national curriculum for physics were sources of the data. The sample of study consisted of 2,880 students enrolled in 10th grade. The reliability of the instrument was confirmed through calculating Cronbach's Alpha score; 0.823. The results of the study showed moderate practice 55.8% for the conduct of practical and poor practices 20.2% for the availability of laboratory apparatus for the conduct of practical. There existed gap between theory and practical periods 8:1 in schools' timetable. Further, the results of the independent sample *t*-test claimed a significant difference between urban and rural schools' teachers in conducting practical work, urban teachers were conducting more practical as compared to rural schools' teachers. The study recommended that government may provide funds to purchase laboratory apparatus, head-teachers ensure availability and functionality of laboratory with apparatus and physics teachers are provided training to conduct practical.

Keywords: *Enacted curriculum; Intended curriculum; Physics practical; Secondary level*

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INTRODUCTION

Curriculum in the totality of learning provided to the learners under school guidance (Marsh & Willis, 2007; Oliva, 2018). It is the lever for promoting positive change and improvement in the country for national development (Hirsch & Reys, 2009). Fundamental types of the curriculum were intended and enacted curriculum (Bouck, 2008; Blignaut, 2009; Cal & Thompson, 2014; Hirsch & Reys, 2009; Spillane et al., 2002). An intended curriculum is a written curriculum that reflects government intentions. In contrast, the enacted curriculum is the delivery of the intended curriculum in the form of textbooks and curriculum materials that define students' needs at a particular grade actually delivered in the classrooms by teachers (Bouck, 2008; Blignaut, 2009; Cal & Thompson, 2014; Hirsch & Reys, 2009; Porter & Smithson, 2001; Spillane et al., 2002).

The effectiveness of the intended curriculum is ascertained through its implementation. Implementation is the process of executing a plan into practice. Curriculum implementation is a procedure of putting the curriculum into classrooms setting (Fullan, 2015; Marsh, 2009; Ornstein & Hunkins, 2014). Curriculum implementation provides guidelines for practicing the intended curriculum in classrooms situation through the efforts of educational management, head-teachers, teachers and students (Fullan, 2015). The focus of curriculum implementation is to obtain curriculum objectives by using specified resources provided in the curriculum. Essential elements of science subjects' curriculum implementation are objectives, content, instructional strategies, assessment and practical work. Practical work implementation is a critical challenge for policymakers, curriculum developers, school management, teachers, students, parents and social stakeholders for teaching learning and skills in science (Chan, 2010; Ornstein & Hunkins, 2014). There is an inclination for practical work to be illustrative in nature rather than the demonstration of laws for conceptual clarification of theories. Practical work is an essential component of science curricula in chemistry, biology and physics at secondary and higher secondary levels in Pakistan. Practical work is also a part of the physics curriculum at the secondary level in Pakistan. Practical help in understanding concepts and processes of science.

Limited research studies have conducted to examine gaps between the intended curriculum and enacted national curriculum for physics practical. There is a discrepancy between the intended curriculum and enacted national curriculum for physics practical. Curriculum implementation gaps exist between overt curriculum and implemented curriculum teachers classroom practices.

Objectives of the Study

The researcher framed the following study objectives to:

1. Measure the conduct of practical for secondary grades students.
2. Examine the gaps between theory and practical period's ratio.
3. Find out the gaps between required and available laboratory apparatus for practical.
4. Compare urban and rural schools practical work implementation.

LITERATURE REVIEW

Science is a systematic way to generate and test knowledge through observation and experimentation. The process and product aspects of science help understand its nature. Science as a product helps to generate new knowledge and, as a process, supports the scientific method to test knowledge in understanding science (Calik, & Coll, 2012; Peters & Kitsantas, 2010). Process skills are essential for learners during learning science subjects.

Effective implementation of physics practical enhances process skills performance of students for purposeful learning (Abrahams, 2005). Science enhances scientific habits of mind towards its process and product aspects. Science inculcates encouragement, engagement, proficiency, self-efficacy, attitudes and self-reflection among learners and teachers for curiosity (Abrahams, 2009; Alsop & Watts, 2003; Hofstein & Lunetta, 2004). It provides the basis for scientifically, technically and economically sustainable development in a country's food, health, environment, energy, communication and mass media (Albe, 2008; Levinson, 2006). Science subjects are divided into chemistry, biology and physics, which are compulsory science subjects at the secondary school level (Government of Pakistan, 2006).

Physics is a compulsory science subject to study matter, energy and their interaction. It is the core science subject to understand laws, principles and theories of physics due to the practical nature of the subject (Alsop & Watts, 2000; Maienschein, 2004). Empirical inquiry is hallmark of understanding science and an essential part of teaching-learning of physics. Practical work is a functioning technique to teach students how to design and conduct an inquiry to solve the problem. Practical work consists of observing, performing and manipulating data for generating new knowledge. Practical work arises interest, concentration, self-reflection, inspiration, contrived learning experiences, and progression in conceptual and procedural knowledge of learning (Abraham & Millar, 2008; Watson, 2000).

Vilaythong (2011) framed the doctoral study in physics to explore the role of practical work in Laos People's Democratic Republic; Lao PDR. The study was descriptive in nature. The data were collected using a questionnaire from 12 teachers and 428 students through convenience sampling. The data were triangulated and collected through percentage, thematic analysis and auto-biography. The findings reported gaps between the intended curriculum and enacted curriculum regarding practical work due to a lack of functional apparatus, allocation of time, and competent teachers for organizing practical work.

Tsai (2003) structured a study in Taiwan to examine secondary school science teachers and students about laboratory activities' effectiveness. The exploratory research design was used to collect data from 1,000 participants through a questionnaire. The results of the study stated that students were more dissatisfied than their teachers with laboratory work.

Danjuma and Adeleye (2015) planned a study in Nigeria to explore the influence of the availability and utilization of physics laboratory equipment in teaching-learning of physics. The study was descriptive in nature. The study sample comprised 50 students and five teachers from secondary schools selected through random sampling. The data were collected through a questionnaire and analyzed by applying percentages. The finding depicted that the laboratory exists 100%, functional apparatus 54%, and lack of functionality and usability of laboratory apparatus for conducting practical.

Abrahams (2005) planned a doctoral study in the UK to examine the use and effectiveness of practical work in secondary schools. The study was descriptive in nature. The sample of the study consisted of 25 teachers and 96 students. The data collected through interviews and observational field notes were analyzed through qualitative data analysis techniques. The results of the study depicted a gap between practical work documents and classroom practices.

Ikoya and Onoyase (2008) planned a study to explore the availability of infrastructure for curriculum implementation in Nigeria. The results of the study reported that public sector secondary school teachers use 50.8% of physics laboratory apparatus for curriculum implementation.

Naseer-ul-Din et al., (2010) structured the study in Punjab Pakistan to examine availability of practical apparatus and conduct of practical. The results of the study explored that science subjects' laboratories were available in schools, but laboratory apparatus were less available, and where apparatus were available, they were not functional. Further, students perform practical a few months before the final board examination at the secondary level for curriculum implementation.

Awan (2015) structured a study in Punjab, Pakistan, to measure the physical conditions of science laboratories for conducting practical. The study was descriptive in nature that used a questionnaire to collect data from 80 science teachers selected through random sampling. The results of the study showed that 51% of teachers were less satisfied with lab apparatus, 62% of teachers were less able to conduct practical, and 87% of teachers were less able to conduct practical due to the non-allocation of practical work periods in the timetable.

The availability of laboratory with apparatus according to the number of students is essential for physics curriculum implementation (Nivalainen et al., 2010). A list of required apparatus for a standard physics laboratory for a group of 40 students and allocated time for conducting practical, weight-age for theory and practical work are stated in the national curriculum for physics grade IX-X (Government of Pakistan, 2006). Theory periods and practical work periods time are allocated in the national curriculum for physics documents. Two periods for physics practical work are allocated in the school timetable, but school management and science teachers do not follow this schedule during teaching physics. Many schools have less practical work timetable. Some schools have a practical work timetable, but practical are not conducted during these periods. Some schools do not allocate practical periods in their school timetable. The numbers of practical work periods are inadequate for science subjects practical. Students perform practical at the secondary school level a few months before the final board examination (Akbar, 2012; Naseer-ul-Din, et al., 2010; Government of Pakistan, 2006). Teachers demonstrate practical work through the lecture method (Patrick, 2009). There is less focus on psychomotor skills development among students. Teachers are unable to conduct practical of the revised curriculum. Only 8% of secondary school science teachers were provided in-service training for conducting practical (Awan, 2015). The results of the research studies reported a gap between the intended and enacted national curriculum for physics practical regarding availability, functionality and usage of laboratory apparatus, a regular schedule of practical, laboratory funds, time allocation for theory, practical periods and teachers' training for practical (Naseer-ul-Din, et al., 2010; Government of Pakistan, 2006; Millar, 2004; Nawaz & Akbar, 2019).

The major purpose of the study was to examine gaps between the intended curriculum and enacted curriculum for the national curriculum for physics grade IX-X, 2006, regarding practical work because fewer studies have been conducted in this area. This study may be helpful for policymakers, curriculum designers, head-teachers, science teachers and other relevant personnel for physics practical implementation. The current study may be helpful for head- teachers and science teachers to ensure conducting practical. The study may be effective for teachers' training institutions for organizing practical work training. The study may be helpful for District Education Authorities to ensure the conduct of practical according to the approved practical schedule.

RESEARCH METHODOLOGY

The current study was conducted to examine gaps between the intended and enacted national curriculum for physics grade IX-X, 2006, focusing on practical work. The sample of the study consisted of 2880 students enrolled in 10th grade selected through a multistage stratified proportionate sampling technique. The study was descriptive in nature, and a quantitative research design was used. The data were collected through a self-constructed Physics Practical Questionnaire; PPQ, and Physics Laboratory Apparatus Checklist; PLAC having dichotomous options. PPQ comprised seven items regarding laboratory availability, the functionality of the laboratory, use of laboratory apparatus, and conduct of practical. PLAC enlisted in the national curriculum for physics comprised of 76 laboratory apparatus instruments (Government of Pakistan, 2006, 2007, 2014). Self-developed PPQ was validated by five physics curriculum educational experts. They added and deleted some items for improvement of the data collection tool. The reliability of the instrument was confirmed through the pilot testing on the sample of 400 students, 200 urban and 200 rural in district Kasur of Punjab province. The reliability of the instrument was confirmed by calculating Cronbach's Alpha Score 0.823. The researcher adopted standard PLAC listed in the national curriculum for physics grade IX-X for collecting laboratory apparatus data from public sector secondary schools of Punjab. The researcher ensured ethical consideration for data collection from the education department, head teachers, and teachers working in public sector secondary schools of Punjab. The collected data were entered in SPSS, and percentage, mean, standard deviation, and independent sample *t*-test were calculated (Casella, & Berger, 2002; Norusis, 2008).

ANALYSIS AND INTERPRETATION OF DATA

The collected data were analyzed in SPSS with the help of statistical techniques mean, standard deviation, percentage and *t*-test.

As presented in Table 1, there were occurring strong practices in the laboratory in the school for practical of physics 89.8%. The laboratory is functional for physics practical 77.3%, practices of teachers conduct physics practical after completing 10th-grade syllabus 83%. There existed moderate practices of adequate equipment and material for physics available according to the number of students 50.7% and apparatus shortage of practical equipment and apparatus 58.4%. There were occurring poor practices teachers conducted topic-related physics practical in the physics laboratory during teaching 10% and physics practical were conducted in 9th class 22%. Overall there existed moderate practices for practical work implementation of the national curriculum for physics 55.8% as established in other studies (Olufunke, 2012; Rogan & Aldous, 2005) in public sector secondary schools of Punjab.

Table 1: Practical work

Sr.#	Statements	Responses (%age)	
		Yes	No
1	The laboratory is available in the school for practical of physics	89.8	10.2
2	The laboratory is functional for practical	77.3	22.7
3	Adequate equipment and material for physics are available according to number of students	50.7	49.3
4	Physics laboratory has shortage of practical equipment and apparatus	58.4	41.6
5	Teachers conduct topic related physics practical during teaching	10	90
6	Physics practical were conducted in 9th class	22	78
7	Teachers conduct physics practical after completing 10th grade syllabus	83	17
	Overall mean score	55.8	44.2

1-30%, poor practices, 31-60%, moderate practices, 61-100%, strong practices

Table 2: Practical periods and theory periods for physics curriculum implementation

Determinant	Standard ratio	Available	Available ratio	Gap
Theory and practical periods in timetable	2: 1	Theory: practical 1915:356	10:1	8: 1

Table 2 reflects the gap between theory and practical periods according to curriculum standards.

Table 3: Required and available laboratory apparatus for standard physics laboratory

Sr.#	Apparatus	Per 40 students	Urban			Rural			Overall		
			Required	Available	Gaps %	Required	Available	Gaps %	Required	Available	Gaps %
1	Vernier calipers	12	5771	3861	66.90	2761	1898	68.75	8532	5759	67.50
2	Screw gauge	12	5771	3871	67.08	2761	1908	69.11	8532	5779	67.73
.	.	.	.	.		.	.	.	.	.	.
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76	Thermistor	5	2405	2378	98.88	1151	1148	100.26	3555	3525	99.16

**Total 76 laboratory apparatus list is available, https://bisep.edu.pk/downloads/curriculum/Grades-IX-X/pk_sc_psc_2006_eng.pdf, item-wise percentage were calculated.*

As delineated in Table 3, overall, there existed a big gap between available and required laboratory apparatus 79.78%, and only 20.2% of laboratory apparatus were available for physics practical.

Table 4: Physics curriculum implementation in terms of teachers' locality

Locality	*N*	*M*	*SD*	*Df*	*t*	*p*
Urban	1440	11.5	1.19	2878	43.424	.05
Rural	1440	9.63	1.11			

Table 4 presented that an independent sample t-test was applied to compare curriculum implementation practices by teachers' locality in terms of practical work. The results established significant difference between teachers' practical work implementation, $t(2878) = 43.424$, $p < .01$; urban schools teachers implementing more curriculum ($M = 11.5$, $SD = 1.19$) as compared to rural teachers ($M = 9.63$, $SD = 1.11$).

DISCUSSION

Science subjects without practical are like a body without soul. Physics practical are an integral part of the science subjects curriculum to discover the natural world. The findings of the current study delineated moderate practices of 55.8% for the conduct of physics practical. Further, there exists a significant difference between urban and rural teachers, the conduct of physics practical and poor practices 20.2% for laboratory apparatus for physics practical. There exists standard ratio gap for theory and practical periods 8:1. The findings of the current study reported gap between standard ratio of theory and practical and laboratory equipment consistent with the result of study framed by Achimugu (2016) declared that 82.3% laboratory apparatus were available and significance difference exists between locality of schools, congruent with findings of study structured by Awan (2015) in Punjab that 51% laboratory apparatus is available and 38% teachers conduct practical according to school practical schedule, align with the results structured by Motswiri (2004) in Botswana declared 62% gap between practical and laboratory apparatus, consistent with the findings of the study structured by Olufunke(2012) that 50.8% laboratory apparatus for physics were available in public sector secondary schools, supported with the findings of the study planned by Vilaythong (2012) reported gap regarding standard conduct of practical, theory and practical ratio, and availability of laboratory apparatus between intended and enacted curriculum for physics practical implementation. The results of the present study were inconsistent with the findings of the study structured by Danjuma and Adeleye (2015) in Nigeria have declared that 100% physics laboratory apparatus available for conducting practical, contradicting the results of the study framed by Abraham (2005) in the UK reported that teachers conduct practical regularly for curriculum implementation. Previous studies established gaps between intended and enacted curriculum regarding standard laboratory apparatus, the conduct of practical, ratio between theory and practical work periods, and no significant difference exists between urban and rural teachers' conduct of practical for curriculum implementation (Ikoya & Onoyase, 2008; Nivalainen et al., 2010; Thair & Treagust, 1999).

CONCLUSION

The study was framed to examine gaps between the intended and enacted national curriculum for physics grade IX-X, 2006 regarding the conduct of physics practical, ratio between theory ad practical and laboratory apparatus for practical implementation in Punjab, Pakistan. Availability, functionality and use of laboratory apparatus for practical increase teachers' pedagogical effectiveness and performance of students regarding practical implementation. The results of this study declared moderate practices 55.8% for the conduct of practical work and poor practices 20.2% for the availability of laboratory apparatus. Further, there exists a significant difference between urban and rural teachers' conduct of physics practical work. The standard ratio for theory and practical periods stated in the national curriculum for physics grades IX-X is 2:1. The existing gap between theory and practical periods is 8:1.

RECOMMENDATIONS

Findings of the study showed that practical were not conducted according to the curriculum standard schedule. It is recommended that physics teachers and head teachers ensure regular conduct of practical according to the academic calendar during the whole academic session. The results of the study declared a gap between the conduct of practical, theory and practical periods, availability of laboratory apparatus focusing on intended and enacted curriculum. It is recommended that monitoring authorities and District Education Authorities may ensure that school head-teachers must allocate practical classes in the school timetable.

The findings of the study showed a shortage of laboratory apparatus in most schools for standard physics laboratories. Regarding science funds provided to schools for the purchase of laboratory equipment and apparatus, it is recommended that the government should provide funds to purchase apparatus for the standard physics laboratory.

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