

Relationship between Secondary School Students' Physics Academic Achievement Scores and their Conceptual Knowledge

Wajid Ali Khan* and Muhammad Saeed**

Abstract

Policies shift their focus from increasing enrolment to quality improvement and enhancing the conceptual knowledge and investigating skills of the students. Students' achievement scores are generally considered the true reflectors of quality improvement. This study investigated the relationship between public sector students' physics achievement scores and their conceptual knowledge at secondary school level. In this quantitative research a self-developed achievement test was used to investigate the conceptual knowledge, validated by six experts and pilot tested. Reliability of the test was found 0.85 Cronbach Alpha. Four secondary schools were selected as clusters from which 135 students were selected randomly. Pearson correlation and independent sample t-test were used for data analysis. Significant positive relationship was found between the variables, academic achievement and conceptual knowledge gender-wise and locale-wise in the subject of physics. Effect size shows the moderate and large size practical significance. This study has some implications for stakeholders in education.

Keywords: Physics, Achievement score, Conceptual knowledge, Revised bloom taxonomy

*Ph.D. Scholar, University of the Punjab, Lahore, Pakistan. Email: wajidalikhanpsy@yahoo.com

**Professor (Rtd), University of the Punjab, Lahore, Pakistan. Email: saeed.ier@pu.edu.pk

Introduction

At all stages of education, tests are considered powerful and important tools for decision making in our competitive and result conscious society at every stage of education. Tests are considered special at secondary school level. Skills, abilities and achievements are assessed through these tests (Rizwan & Nasir, 2010). Physics is one of the basic subject of physical sciences through which this world and its complexities, necessary technological advancement can be understood (Erinosho, 2013). In subjects of physical sciences physics holds a dominant sensitive position (Shamim, et al., 2013). Physics is considered as tough and difficult subject in school curriculum and, due to this, the enrolment in this subject is decreasing in advanced countries, e.g. USA, UK, Germany and Netherland. Other studies also show an alarming number of low enrolment in related combinations of physics subject across the globe especially at higher level of studies (Checkley, 2010). The main reason of this decline may be the passive teaching methods mostly used by teachers in classrooms of physics. It is further investigated in a survey conducted in a secondary school of United Kingdom that why students' are not interested in studying physics subject. It appeared that students perceive that physics as a tough subject to study. Physics is considered by students as hard subject due to its problem solving nature (Byun & Lee, 2008). Students are explicitly taught to solve physics problems so students feel it difficult (Heller & Heller, 2000). In physics learning, students mostly face difficulties in four areas; (i) Misconceptions present in the statements of the problems, (ii) Misreading and/or misinterpretation of the question posed, (iii) Weak mathematical ability of the students and (iv) Confusion in understanding of closed meaning terminology (Ding, 2007). These are the major factors responsible for students' difficulties in learning physics but data states that other factors may also be responsible. It is also perceived that physics plays an important role for the development of concept and learning techniques in other subjects of physical sciences (Sheriff, et al., 2011).

Conceptual knowledge is significant to solve the problems in the subject of physics and select procedures for the solution of problem. Conceptual knowledge helps students at different situations to understand and explain the phenomenon employed in these different situations. Memorization and rote learning are not the effective ways to understand the advanced scientific concepts. It is necessary to understand the physics concepts by rereading, self-explanation, and elaborative interrogation because students cannot understand the concepts of subjects of different disciplines only through memorization. The concepts understood by a learner help a person to create a suitable sense in existing knowledge of a person (Venville & Dawson, 2010). Constructivists' perceived new knowledge may be developed on the basis of previous knowledge or new knowledge must be connected with previous knowledge in a conceptual change.

Schools are facing poor performance in all its sectors of education especially at secondary level (Shamim, et al., 2013). In the subject of physics, low performance may be linked with poor concept learning. There is a weakness found in students' conceptual knowledge. In solving physics problems, there is a lacking of conceptual understanding found in conceptual usage. Many students can solve the physics problems in written successfully but they may fail when they are asked questions orally. This whole process reflects that students focus only on memorization of formulas and equations without understanding their concepts. Students do not use their conceptual knowledge and intellectual abilities effectively to solve the problems.

Learning by memorization is the main cause for the forgetfulness of physics concepts. Outside the classroom, students cannot apply their knowledge because of their memorization of formulas. It has been also noted that students memorize the lessons in order to pass exams. Studies conducted abroad posited that students' cognitive and affective abilities and their learning are positively affected by conceptual knowledge and change (Amin, et al., 2014). In the same way, Chappell and Killpatrick (2003) state that improvement in students' understanding may be enhanced by the concept based learning.

Achievement scores show the learning of students. It is usually considered that high achievers have more competence, concepts and skills in that subject. There are few studies at international level on the relationship between students' physics achievement and conceptual knowledge. The main concern of this study was to see whether conceptual knowledge and creative abilities of secondary school level students correspond to their high marks/grades in Pakistan.

The above discussion shows that there are various weaknesses in students' conceptual knowledge to solve the problems. Hence this study finding the relationship between conceptual knowledge and academic achievement may help to predict the effectiveness of conceptual knowledge for the learning of physics subject. Present study was designed to find out the relationship between physics students' academic achievement and their conceptual knowledge at secondary school level in Pakistan.

Theoretical Framework

Learning is considered as a cognitive phenomenon (Anderson, 2005). Higher learning is based on conceptual learning as explained by different theorists (Doleck, et al., 2017). Conceptual learning is a conscious process as described by theorists that conceptual learning involves thinking and reasoning.

Bloom (1956) has recommended the division of cognitive learning in six domains which are known widely as cognitive domains. Anderson (2005) further categorized learning process into six verb based levels of cognitive domains. These are in hierarchy of

low level of learning to high level of learning. These domains have been renamed as knowledge into remember, comprehend into understand, application into apply, analysis into analyze, synthesis into create, and evaluation into evaluate. Creating has been shifted at the top of leaning domain (Malik, et al., 2019). These levels are connected with each other with concept learning process from easy to complex. At first two stages learner recalls the information and then comprehend the concepts to explain.

There is much guidance for learners in Piaget's learning theory which explained this process stage by stage. The four stages of Piaget's learning theory depict the true picture of connected process of conceptual learning. It is also explained in this theory about the nature of concept learning as the cognitive process of learning (Doleck, et al., 2017).

Conceptual learning is a cognitive phenomenon so that this study comes under the domain of cognitive theories of concept learning. It is endorsed by Doleck, et al. (2017) that conceptual learning is a cognitive process and should be carried out under the guidelines of cognitive theories.

Conceptual Framework

To find out the relationship between students' academic achievement of physics and conceptual knowledge is the main objective of this study. Remember and understand were two main levels of Revised Bloom's taxonomy selected in this study. Figure 1 explains the complete framework of the study by showing the relationship between variables.

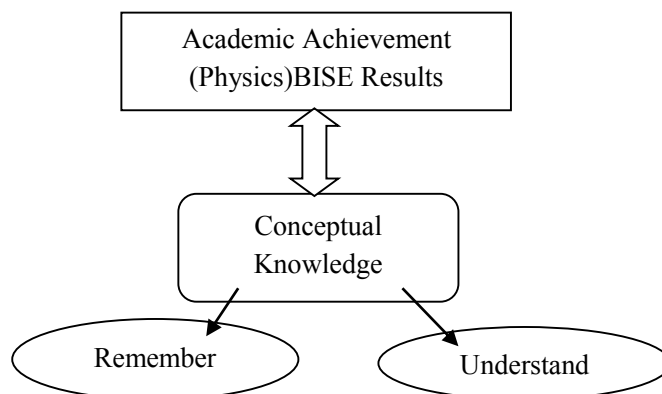


Figure 1. *Conceptual Framework*

Significance of the Study

Study is significant for all educational curriculum relating stakeholders. It is also helpful for science teachers to teach physics effectively by giving conceptual knowledge and improving the educational activities for students. The most beneficiary of this study are secondary school level students who may improve their conceptual knowledge and make it useful for their future studies. Study is helpful in developing activities and material which produce conceptual knowledge in students and achieving Structured Learning Outcomes (SLOs) of physics subject at secondary level.

Teacher training programs and courses may be made more effective and comprehensive by adding such knowledge and activities. This study will enable science teachers to practice conceptual learning in classroom making students' knowledge and results better. Study is significant for teacher training institutions to include such knowledge in their training programs. It will help physics teachers to practice conceptual knowledge in real classroom teaching.

Research Objectives

Study was to:

1. Investigate the relationship between 9th grade students' academic achievement and conceptual knowledge in the subject of physics.
2. Find out the mean score difference of boys and girls of 9th grade students' academic achievement and conceptual knowledge in the subject of physics.
3. Find out the mean score difference of urban and rural of 9th grade students' academic achievement and conceptual knowledge in the subject of physics.

Research Methodology

The study was descriptive in nature. A correlational design was employed in the present study to explore the relationship between physics students' academic achievement conceptual knowledge in the subject of physics.

Five hundred and six students of 9th grade appeared in physics subject in annual examination conducted by Board of Intermediate and Secondary Education Lahore (BISE) in 2019 from four selected schools were target population of this study.. In selecting the sample of the study, multistage sampling technique was used. At first stage, 04 public sector secondary schools [02 boys and 02 girls (02 urban and 02 rural)] were selected randomly as cluster from district Sheikhpura, Pakistan. According to schools record 600 students took the examination of 9th grade and 506 students on achieving 33% marks in the subject of physics passed the examination. At second stage, by employing simple random sampling technique (lottery method) 135 students [63 boys and 72 girls (71 urban and 64 rural)] were selected as sample of the study.

Instrumentation

An achievement test was developed for data collection to find out the relationship between physics students' academic achievement and conceptual knowledge. Items of different levels such as remember and understand of Revised Bloom's Taxonomy (RBT) of cognitive domain were developed. The content of this test was taken from physics textbook for grade 9 published by Punjab Curriculum and Textbook Board (PCTB) Lahore in 2019-20. Test was developed as per BISE paper pattern.

Bloom's Taxonomy was further revised by Bloom's student Lorin Anderson (2005) and structured in a new form of taxonomy having two dimensions. Horizontal dimension consisting of cognitive dimension replacing the noun form with verbs e.g: Remember, Understand, Apply, Analyze, Evaluate, and Create. Vertical dimension consisted of content dimension labeled as: Factual, Conceptual, Procedural and Metacognitive Knowledge (Anderson, 2005).

		Content Dimension			
		Facts	Concepts	Principles	Procedure
Cognitive Dimension	Remember				
	Understand				
	Apply				
	Analyze				
	Others				

Figure 2. Revised Bloom's Cognitive Domains with Content Dimension

In the field of research, mostly, three formats are popular, multiple choice test format, the constructed response test format, and performance based test format. Most widely used test is multiple choice test questions which are easy to grade, convenient to analyze the data and use of statistical tests, e.g. descriptive and inferential statistics, easy and efficiently administered, the results are often generalizable. Different cognitive behaviors can be covered through multiple choice tests as well as knowledge content can also be covered by these tests at different levels to evaluate the higher order thinking such as application of principles, a well-designed multiple choice test is also feasible (Ding, 2007).

MCQs test items were of remember and understand level cognitive domains and it covered knowledge of facts, concepts, and principles in physics. This test contained 22 items; 11 of remember and 11 of understand level, each item carried 01 mark. This test was

of 30-45 minutes. The test was constructed by following scientific method by developing table of specification to maintain its validity and reliability.

Six experts of the field validated the instrument. Their valuable suggestions were incorporated to make the test valid for the study. Cronbach alpha reliability was 0.85 which is recommended as good for any achievement test. It is excellent if greater than 0.80 and adequate if lies in 0.60 to 0.79 (Law, 2004). For item analysis, item difficulty index, item discrimination index, and point bi-serial were found and for test analysis reliability index and Ferguson delta were found. Its brief description is given below.

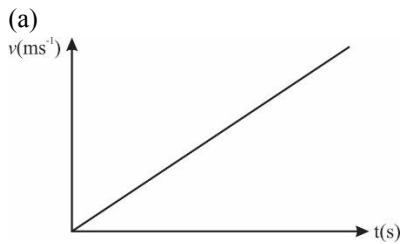
Table 1
Evaluation of the Pilot Version Test of Conceptual Knowledge

Test statistics	Desired values	Values of the Pilot Version
Difficulty Index	[0.3, 0.9]	0.41-0.71
Discrimination Index	≥ 0.3	0.17-0.59
Point bi-serial coefficient	≥ 0.2	0.1-0.24
Reliability Index	≥ 0.7	0.85
Ferguson's Delta	≥ 0.9	0.99

According to table 1 all the parameters of the test were according to the desired values. Difficulty index of items falls in the range 0.41-0.71, discrimination index ranges between 0.17-0.59 and point bi-serial values lies within 0.1-0.24.

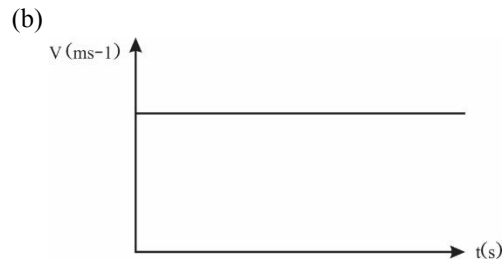
In the light of these results and experts' recommendations, ambiguous items were reviewed and improved to finalize the test. The content for this test was selected according to physics textbook for IX class students published by Punjab Curriculum and Textbook Board (PCTB) Lahore. There are sampled three items containing knowledge of concepts, facts, and principles respectively.

1. Indicate the graph which shows the uniform acceleration?

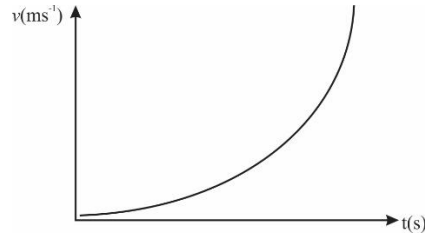
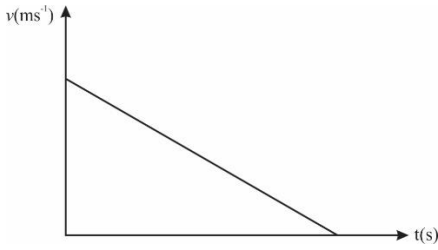


(c)

نشان دہی کریں کہ کون سا گراف یکساں ایکسیریشن کو ظاہر کرتا ہے؟



(d)



2. The value of one horse power is equivalent to:
- 546 watts
 - 646 watts
 - 746 watts
 - 846 watts
3. If the kinetic energy of a moving body having a mass of 4 kg is 18 J, its speed will be:
- 3 ms^{-1}
 - 6 ms^{-1}
 - 9 ms^{-1}
 - 12 ms^{-1}

ہارس پاؤور کی قیمت ہوتی ہے:

(a) 546 واٹ

(b) 646 واٹ

(c) 746 واٹ

(d) 846 واٹ

اگر ایک 4 کلوگرام جسم کی کائی نیٹک انرجی 18 جول ہو تو اس کی سپیڈ ہوگی:

(a) 3 ms^{-1}

(b) 6 ms^{-1}

(c) 9 ms^{-1}

(d) 12 ms^{-1}

Data Collection

Data were collected after the due permission of heads of the respective institutions and class teachers. Students were informed one week prior to the test about the nature of the test and its construction of items 22 MCQs. Test was personally conducted and marked according to the rubrics validated by 04 experts. Rubrics were developed as per criteria of BISE Lahore. Data of academic achievement were collected from school teachers and verified from data of Annual Gazette 2019 issued by Board of Intermediate and Secondary Education, Lahore.

Data Analysis and Interpretation

Inferential and descriptive statistics were used to analyze the data. Descriptive statistics provides an understanding of the different dimensions of data while inferential analysis was to find out the relationship between academic achievement and conceptual knowledge test scores.

Table 2

Gender-wise Analysis of Students' Academic Achievement and Conceptual Knowledge

Variable	Gender	N	Mean	SD
Academic Achievement	Boys	63	41.43	5.642
	Girls	72	44.65	5.744
Conceptual Knowledge	Boys	63	13.83	1.996
	Girls	72	14.57	1.837

Table 2 explains the detailed descriptive statistics of the data about academic achievement and conceptual knowledge of the students. According to this table highest mean score was found for academic achievement of girls (M =44.65, S.D. =5.744) followed by the achievement of the boys (M =41.65, S.D. =5.642). Similarly mean score of conceptual knowledge of girls (M =14.57, S.D. =1.837) is higher than boys (M =13.83, S.D. =1.996). The results show that although the performance of girls is better than boys but there is more variation in the results of girls than boys as shown in (SD=5.744, SD=5.642) but less in conceptual knowledge (SD=5.1.837, SD=1.966) respectively. This shows that academic performance and conceptual knowledge of girls is better than boys but there is more consistency in boys' results than girls in conceptual knowledge but less than academic achievement.

Table 3

Locale-wise Analysis of Students' Academic Achievement and Conceptual Knowledge

Variable	Locale	N	Mean	SD
Academic Achievement	Urban	71	47.14	3.305
	Rural	64	38.72	4.900
Conceptual Knowledge	Urban	71	15.61	1.102
	Rural	64	12.69	1.657

In table 3 descriptive statistics about academic achievement and conceptual knowledge of the students are shown. According to this table the academic achievement mean score of urban students' (M =47.14, SD=3.305) was found higher than rural students (M =38.72, SD=4.900). Similarly in case of conceptual knowledge, urban students showed better results (M=15.61, SD=1.102) than rural students (M =12.69, SD= 1.657). Variations of the results are less in urban students (SD=3.305, 1.102) than rural students (SD=4.900, 1.657) in academic achievement as well as in conceptual knowledge. These differences show that urban students' results are more consistent than rural students.

A linear relationship between the variables is shown in scatter plot of Figure 3. This graph also shows positive relationship between academic achievement score and conceptual knowledge of the students. More academic achievement means more conceptual knowledge in the students in subject of physics and vice versa. This shows the direct proportion in the variables.

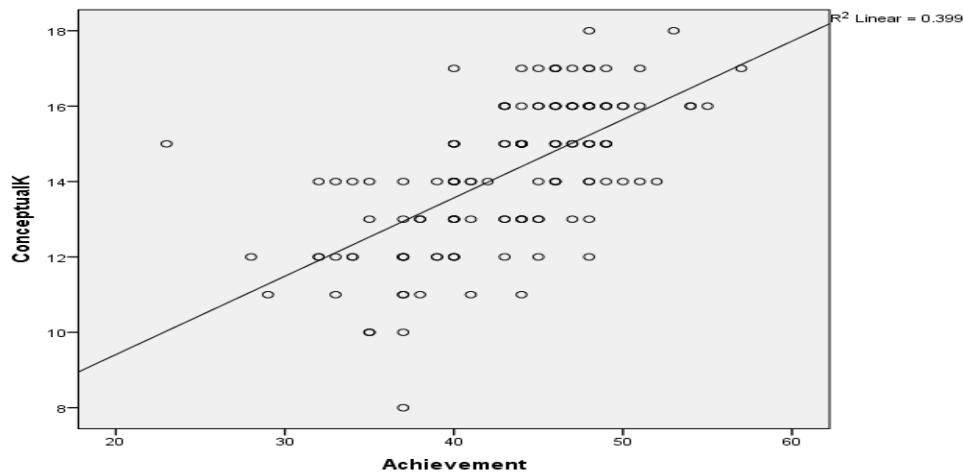


Figure 3. Relationship between Academic Achievement Score and Conceptual Knowledge Score

Table 4

Relationship between Students' Academic Achievement Scores and Conceptual Knowledge

Variable	Conceptual Knowledge
Academic Achievement	.631*

*Correlation is significant at .05 level (2 tailed), n=135

Table 4 shows the relationship value of academic achievement and conceptual knowledge after applying the Pearson product moment correlation. It is reflected by results that there is a strong level of association between these variables, ($r = .631$, $p = .000$) and this association was significant ($p < .05$). In conclusion, there is a strong level likelihood that if academic achievement scores of students' increases or decreases then the score of conceptual knowledge will also increases or decreases.

Table 5

Results of t-test Comparing Students Academic Achievement and Conceptual Knowledge Gender-wise

Variable	Gender	N	Mean	SD	T	df	Sig. (p)*	g
Academic Achievement	Boys	63	41.43	5.642	-3.285	133	.001	0.56
	Girls	72	44.65	5.744				
Conceptual Knowledge	Boys	63	13.83	1.996	-2.242	127	.027	0.33
	Girls	72	14.47	1.837				

*p is significant at 0.05 levels.

Table 5 explains that for comparing the scores of boys and girls students' physics academic achievement and conceptual knowledge, independent sample t-test was used. Results depict that boys students showed lower performance ($M = 41.43$, $SD = 5.642$) than girls students ($M = 44.65$, $SD = 5.744$) in terms of students' academic achievement in the

subject of physics. This result is statistically significant, $t(133) = -3.285$, $p < .05$. Hedges' effect size value ($g=0.56$) suggested moderate level practical significance. Results show the less variation in academic achievement scores of boys' than girls' students' in physics subject. Statistically significant mean score difference is found in students' academic achievement in terms of gender.

Similarly results show that boys students' showed slight lower performance ($M = 13.83$, $SD = 1.996$) than girls students' ($M = 14.47$, $SD = 1.837$) in terms of conceptual knowledge of students' in subject of physics. This result is statistically significant, $t(133) = -2.242$, $p < .05$. Hedges' effect size value ($g=0.33$) suggested moderate level practical significance. Results show that there is large variation in boys' students' than girls' students' conceptual knowledge scores. Again statistically significant mean score difference is found in students' conceptual knowledge in terms of gender.

Table 6

Results of t-test Comparing Students Remember and Understand Levels Gender-wise

Variable	Gender	N	Mean	SD	T	df	Sig.(p)*	g
Remember	Boys	63	6.78	1.641	-6.132	128	.000	0.56
	Girls	72	8.47	1.556				
Understand	Boys	63	6.30	1.227	-2.738	132	.007	0.33
	Girls	72	6.94	1.500				

*p is significant at 0.05 levels.

Table 6 shows comparison of remember and understand level by applying independent sample t-test statistics. Results depict that boys students' showed lower performance ($M = 6.78$, $SD = 1.641$) than girls students' ($M = 8.47$, $SD = 1.556$) in terms of students' remember in the subject of physics. This result is statistically significant, $t(128) = -6.132$, $p < .05$. Hedges' effect size value ($g=0.56$) suggested moderate level of practical significance. Results show that there is less variation in knowledge scores of girls' students' than boys' students' in physics subject. It is concluded that there is a significant difference in students' remember gender-wise.

Similarly results show that boys students' showed slight lower performance ($M = 6.30$, $SD = 1.227$) than girls students' ($M = 6.94$, $SD = 1.500$) in terms of understand of students' in subject of physics. This result is statistically significant, $t(132) = -2.738$, $p < .05$. Hedges' effect size value ($g=0.33$) suggested moderate level practical significance. Results show that there is large variation in girls students' than boys students' understand scores in the subject of physics. It is concluded that there is statistically significant mean score difference in students' understand in terms of gender.

Table 7

Comparison of t-test results of students' Physics Achievement and Conceptual Knowledge Locale-wise

Variable	Locale	N	Mean	SD	T	df	Sig. (p)*	g
Academic Achievement	Urban	71	47.14	3.305	11.808	133	.000	1.79
	Rural	64	39.72	4.900				
Conceptual Knowledge	Urban	71	15.61	1.102	13.016	133	.000	1.83
	Rural	64	12.99	1.657				

*p is significant at 0.05 levels.

Table 7 shows comparison of the scores of students' physics academic achievement and conceptual knowledge. Independent sample t-test was applied to analyze the data. Results depict that rural students' showed lower performance ($M = 39.72$, $SD = 4.900$) in academic performance than urban students' ($M = 47.14$, $SD = 3.305$) in terms of locale in physics subject. This result is statistically significant, $t(133) = 11.806$, $p < .05$. Hedges' effect size value ($g=1.79$) suggested large level practical significance. Results also show that there is large variation in rural students' than urban students' academic performance in physics subject. It is concluded from results that there is a significant mean difference in students' academic achievement locale-wise.

Similarly results show that rural students' showed lower performance ($M = 12.99$, $SD = 1.657$) than urban students' ($M = 15.61$, $SD = 1.102$) in terms of conceptual knowledge of students' in subject of physics. This result is statistically significant, $t(133) = 13.016$, $p < .05$. Hedges' effect size value ($g=1.83$) suggested large level practical significance. Results show that there is less variation in urban students' than rural students' conceptual knowledge scores in physics subject. It is concluded that difference in mean scores is significant in terms of conceptual knowledge of students locale-wise.

Table 8

Comparison of t-test results of students' Physics Remember and Understand Levels Locale-wise

Variable	Locale	N	Mean	SD	T	df	Sig. (p)*	g
Remember	Urban	71	7.69	1.527	0.058	133	.954	1.79
	Rural	64	7.67	2.078				
Understand	Urban	71	7.00	1.331	3.186	133	.002	1.83
	Rural	64	6.25	1.403				

*p is significant at 0.05 levels.

Table 8 explains the comparison for the scores of students' physics remember and understand by using independent sample t-test. Results depict that rural students' showed slightly lower performance ($M = 7.67$, $SD = 2.078$) in remember than urban students' ($M = 7.69$, $SD = 1.527$) in terms of locale in physics subject. This result is statistically non-significant, $t(133) = 0.058$, $p > .05$. Hedges' effect size value ($g=1.79$) suggested large

level practical significance. Results also show that there is large variation in rural students' than urban students' remember in physics subject. It is concluded that according to locale-wise, non-significant mean score difference is found in students' remember.

Similarly results show that rural students' showed lower performance ($M = 6.25$, $SD = 1.403$) than urban students' ($M = 7.00$, $SD = 1.331$) in terms of understand of students' in subject of physics. This result is statistically significant, $t(133) = 3.186$, $p < .05$. Hedges' effect size value ($g=1.83$) suggested large level practical significance. Results show that there is less variation in urban students' than rural students' understand scores in physics subject. It is concluded that there is a statistically significant mean score difference is found in students' understand in terms of locale.

Discussion

On the basis of the above findings the focus of the study was to find the relative relationship of students' academic achievement with conceptual knowledge. Cognitive factors, e.g. knowledge and comprehension are pivotal in generating conceptual knowledge. Both academic achievement and conceptual knowledge play significant role in academic and practical field of students' life.

A strong positive relationship between academic achievement and conceptual knowledge was depicted by data. Study results were aligned with (Khan, et al., 2017). Both studies are also stated relationship between academic knowledge and conceptual knowledge. It is concluded from above results that conceptual knowledge has an important significance in students' learning. The more conceptual knowledge, the more achievement score of the student will be. Through conceptual knowledge student can solve the problem those are out of prescribed syllabus (Azhar, et al., 2020). Conceptual knowledge positively improves the capability of concept using. These concepts are also helpful for the students in solving the problems similar in other subjects. This finding was in line with the findings of the studies reported in literature (Ding, 2007).

According to the results, significant means score difference is found in students' academic achievement and conceptual knowledge gender-wise. According to the findings, girls showed better results than boys and these results are according to Fatoba and Aldejana (2014) who stated in their study the same results. In this case gender-wise, girls students showed better performance in knowledge and comprehension than boys students and these results are consistent with (Aina & Akintunde, 2013). This is may be due to the more commitment of girls' students than boys' students. It may further be due to the cultural settings in Pakistan.

According to data analysis, a significant means score difference is found between academic achievement and conceptual knowledge of students' locale-wise in the subject of physics. According to these results, urban students performed better than rural students in their academic achievement and conceptual knowledge of physics subject at secondary school level. In another study Taslidere (2020) also found that results of rural students are lower than urban students. Similarly, in locale again results are significant in academic achievement and conceptual knowledge, explained by Azhary, et al.(2020). In this case urban students showed better performance in knowledge and comprehension than rural students and these results are consistent with Mekonnen (2014). This further shows that results are due to the non- availability of infrastructure and facilities in rural area schools.

Based on the above discussion, it was found that relationship between discussed variables was strong and significant difference was found between academic achievement and conceptual knowledge gender-wise and locale-wise. So, it is concluded that there is a significant mean score difference between urban and rural students' physics academic achievement and conceptual knowledge. Similarly, boys and girls students are also showed significant performance in their physics academic achievement and conceptual knowledge.

Conclusion

It is concluded that study results are evidences for secondary school science students conceptual knowledge about content related to physics is less. In particular, it seems that the less science students know about in depth conceptual knowledge of physics, due to this their achievement scores are also low. On the other hand, between academic achievement and conceptual knowledge a significant relationship was found. But relationship at some extent was strong. Further boys students showed low performance than girls students and rural students showed low results than urban students. It is same in case of their knowledge and comprehension respectively. More over a significant mean score differences are found in results of students' gender-wise and locale-wise. It can be related with above findings about low level of conceptual knowledge is due to low achievement scores and vice versa. The study concludes that low achievers show low progress in their conceptual knowledge and high achievers show high performance.

Recommendations

Following are recommendations based on the conclusions of the study:

1. Secondary school physics students are recommended to make their study by employing rereading and self-explanation to develop their conceptual knowledge in the subject of physics to improve their academic achievement.

2. Secondary school physics teachers are recommended to teach the students in a way to develop conceptual knowledge. They may consult Thorton's book "Teaching Physics Concepts with Activity Based Learning." It may help them to improve their academic achievement in the subject of physics.
3. Stakeholders related to secondary school physics curriculum and textbook to develop textbooks by designing activities which physics teachers and students may experience to develop their conceptual knowledge that may results their improved academic achievement.

References

- Aina, J. K., & Akintunde, Z. T. (2013). Analysis of gender performance in physics in college of education, Nigeria. *Journal of Education and Practice*, 4(6), 1-5.
- Amin, T. G., Smith, C. L., & Wisner, M. (2014). Student conceptions and conceptual change. In N. G. Lederman, & S. K. Abell (Eds.), *Handbook of research on science education* (pp. 57-81). Routledge.
- Anderson, L. W. (2005). Objectives, evaluation, and the improvement of education. *Studies in Educational Evaluation*, 2(31), 102-113.
- Azhary, S. A., Supahar, S., Kuswanto, K., Ikhlas, M., & Devi, I. P. (2020). Relationship between behavior of learning and student achievement in physics subject. *Jurnal Pendidikan Fisika Indonesia*, 16(1), 1-8.
- Board of Intermediate and Secondary Education (2019). *Annual Gazette 2019*. BISE Press.
- Byun, T., Ha, S. & Lee, G. (2008). Identifying student difficulty in problem solving process via the framework of the house model. *Proceedings of the Physics Education Research Conference*, 1064, 87-90.
- Chappell, K. K., & Killpatrick, K. (2003). Effects of concept-based instruction on students' conceptual understanding and procedural knowledge of Calculus. 13(1), *PRIMUS*.17-37.
- Checkley, D. (2010). *High school students' perceptions of physics*. <https://www.uleth.ca/dspace/bitstream/handle/10133/2584/checkley%2C%20doug.pdf>.
- Ding, L. (2007). *Designing an energy assessment to evaluate student understanding of energy topics*. Ph. D. Dissertation, Department of Physics, North Carolina State University.
- Doleck, T., Bazalais, P., Lemay, D. J., Saxena, A., & Basnet, R. B. (2017). Algorithmic thinking, cooperativity, creativity, critical thinking, and problem solving: exploring the relationship between computational thinking skills and academic performance. *Journal of Computers in Education*, 4(4), 355-369.

- Erinosho, S. Y. (2013). How do students perceive the difficulty of physics in secondary school? An exploratory study in Nigeria. *International Journal of Cross-disciplinary Subjects in Education (IJCDSE) Special Issue*, 3(3), 1510-1515.
- Fatoba, J. O., & Aladejana, A. L. (2014). Effects of gender on students' attitude to physics in secondary schools in Oyo State, Nigeria. *European Scientific Journal*, 10(7), 399-404.
- Khan, K., Majoka, M. I., Khurshid, K., & Shah, S. M. H. (2017). Impact of active learning method on students' academic achievement in physics at secondary school level in Pakistan. *Journal of Education and Educational Development*, 5(2), 134-151.
- Law, M. (2004). Outcome measures rating from guidelines. *Journal of Occupational Therapy*, 54, 133-138. <http://www.pubmedcentral.nih.gov/articlerender>.
- Malik, A., Novita, Y., & Nuryantini, A. Y. (2019). Enhancing critical thinking skills of students related to temperature and heat topics through problem solving-laboratory model. *Jurnal Penelitian & Pengembangan Pendidikan Fisika*, 5(1), 9-20.
- Mekonnen, S. (2014). Problems challenging the academic performance of physics students in higher governmental schools of Ethiopia. *Natural Science*, 5(6), 362-375.
- Pakistan, Government of (2006). *National Curriculum of Physics 2006*. Ministry of Education.
- Rana, R. A., & Mahmood, N. (2010). The Relationship between test anxiety and academic achievement. *Bulletin of Education and Research*, 32(2), 63- 74.
- Shamim, M, Rashid, T, & Rashid, R. (2013). Students' academic performance in physics correlates the experience of teachers in higher secondary schools of Jammu and Kashmir state. *International Journal of Current Research*, 5(1), 201-204.
- Sheriff, M. A. Maina, B. T. & Umar, Y. (2011). Physics in education and human resources development. *Continental Journal of Education Research*, 4(3), 23-36.
- Taslidere, E. (2020). Factors affecting 12th-grade students' physics achievement. *Psychology in the Schools*, 4(2), 23-35.
- Venville, G. J., & Dawson, V. M. (2010). The impact of a classroom intervention on grade 10 students' argumentation skills, informal reasoning, and conceptual understanding of science. *Journal of Research in Science Teaching*, 47(8), 952-977.