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Exploration of Student-Centered Teaching Methods: Physics Curriculum Implementation Perspectives

Haq Nawaz[1] & Rafaqat Ali Akbar[2]

Abstract

Teaching methods are primary elements of curriculum. National curriculum provides for student-centered teaching methods including for the subject of physics. Focusing on the importance of teaching methods, the current quantitative study was planned to explore student-centered teaching methods used for physics curriculum implementation. The sample of the study comprised 2,880 science students selected through multistage sampling technique. Self-constructed questionnaire having 4-factors; small group discussion, project work, inquiry teaching and debate were used to collect the data from the respondents. The questionnaire was validated from the experts and pilot tested to ensure Cronbach's Alpha reliability statistics; .823. The data were analyzed through descriptive statistics and independent sample t-test. Results declared that teachers were making 56% use of student-centered teaching methods. Furthermore, urban secondary schools' teachers were making more use of student-centered teaching as compared to rural secondary schools' teachers for curriculum implementation. Based on the results, it is recommended that physics teachers should be provided training in student-centered teaching methods for effective curriculum implementation.

Keywords: Implementation, national curriculum for physics, student-centered teaching methods

Introduction

School is a distinctive place that arranges academic activities for engaging students. Effective accomplishment of these academic activities requires framework in the form of curriculum. Curriculum is the plan of educational activities carried out inside or outside the school to determine goals of education (Tala, 2012). Objectives, content, teaching methods and assessment are primary elements of curriculum (Government of Pakistan, 2006; Ornstein & Hukkins, 2014; Walker, 2003; Wiles & Bondi, 2019).

[1] PhD Scholar, Institute of Education and Research, University of the Punjab Lahore, Pakistan. Email: haqnawazsheroz@gmail.com
[2] Director, Institute of Education and Research, University of the Punjab, Pakistan.

Intended curriculum and enacted curriculum are basic types of curricula. Intended curriculum is designed to attain educational aims of the country. Enacted curriculum is like implementation framework based on intended curriculum guidelines in educational institutions for innovatory practices. Implementation is process of putting plan into practice to achieve certain educational objectives. Curriculum implementation process involves set of activities through the efforts of policy makers, curriculum experts, practitioners, school management, teachers and learners for putting intended curriculum into classroom reality (Adams, 2000; Fullan, 2015; Ornstein & Hukkins, 2014; Oliva, 2018). Teachers are real implementer and key to success of curriculum reform. They translate curriculum framework into reality (Guskey, 2002; Oliva, 2018; Smith & Desimone, 2003) and decide what to teach and how to teach (Driscoll, 2005; Oliva, 2018). Real enactment of intended curriculum was limited in classroom practices (Clark-Wilson & Hoyles, 2019). There is gap between curriculum document and classroom teaching practices (Chisholm & Leyendecker, 2008; Government of Pakistan, 2014). Teachers use teaching methods to bridge gap between intended and implemented curriculum (Casado, 2000; Jan, 2013). Success/failure of curriculum implementation depends on teachers teaching methods (Vin-Mbah, 2012).

Teaching methods are effective indicators to implement curriculum. Philosophy of subject is translated into classroom through appropriate teaching methods (Nehru, 2015). Teaching methods are means to facilitate students learning and to gain intended instructional objectives and students learning outcomes based on nature of content of subject, teacher subject knowledge, teaching principles, instructional materials, physical facilities, school environment, age of the leaners and learning activities (Casado, 2000; Dorgu, 2015; Government of Pakistan, 2007; Kumar, 2001; Mehmood & Rehman, 2011; Omwirhiren & Ibrahim, 2016; Vin-Mbah, 2012). Focus of the current study is rooted in science subjects; physics that is considered as crown of entire subjects (Cleaves, 2005; Ravi, 2000). Physics is essential subject to understand chemistry, biology, mathematics, statics, geography and other allied subjects (Dayal, Bhatt, & Ray, 2007; Schmidt, Wang & McKnight, 2005). Physics is taught as one of the compulsory subjects at secondary and higher secondary classes (Government of Pakistan, 2006). Teaching of physics plays a critical role for economic, scientific, and technological development of the country (Ravi, 2000; Vanaja & Rao, 2004). Inquiry nature of physics engages learners in scientific process to explore real world phenomenon. Teachers deliberately work to align curriculum reform with instructional practices (Drake & Sherin, 2006). Teaching methods are transferred ways of thinking that promote individual autonomy and open-mindedness for effectiveness of teaching and learning (Tabulawa, 2003). Teaching methods play an important role in learning, developing skills among

students and translating theory into practice (Hamdare, 2013; Nehru, 2015; Rao, 2004). Student-centered teaching methods promote elements of constructive approach (Chisholm & Leyendecker, 2008; Jan, 2013). National curriculum document 2006 explained small group discussion, project work, inquiry, and debate (Government of Pakistan, 2006).

Small group discussion refers to the group interaction in which learners exchange their experiences and opinions with other students. Students share and listen to the views of others. Students become less dependent on their teachers. Teachers act as facilitators to engage students in learning. Students do probe, compare, analyze, evaluate, and draw conclusion of the problem under discussion (Rao, Sreedhar, & Rao, 2006). Hamdare (2013) identified principles for effective teaching; dealing with students' existing ideas and concepts, encouraging students' participation in classroom and to provide feedback. Small group discussion enhances communication skills, peer interaction, psycho-social skills, critical thinking, teamwork, and self-directed learning (Barkley, 2009; Debore, 2002; Government of Pakistan, 2006; Mehmood & Rehman, 2011; Rao et al., 2006; Trudel & Metioui, 2008). Group discussions enhance students' social competences (Natving, Albrektsen, & QvarnstrØm, 2003; Perry, Donohue, & Weinstein, 2007; Tosey, 2002). Yildirim (1997) planned study in Turkey on sample of randomly selected 1,465 respondents to explore the effectiveness of physics curriculum implementation. Findings revealed that 53.6% teachers use discussion methods for curriculum implementation. *Project work* is outcome of progressive educational movement and was provided concrete shape by John Dewey and William Head Kilpatrick (Rao et al., 2006; Ravitch, 2000). Project work consisted of introduction, task, resources, process, guidance and scaffolding, collaborative learning, and reflection (Grant, 2002), driving questions, learning goals, scientific practices, collaborative activities, learning technology, scaffolding and creation of artifacts (Buabeng, Ossei-Anto, & Ampiah, 2014; Krajcik & Shin, 2014). Common elements of project work are selecting problem, planning, executing, recording, and reporting. Project work approach emphasizes cognitive competencies, deep learning, and development of specific content knowledge in subject area (Helm, & Katz, 2016; Kibert & Kathuri, 2005; Pellegrino & Hilton, 2012; Ravitch, 2000; Scardamalia, Bransford, Kozma, & Quellmalz, 2012). Cognitive and physical involvement of students in project work provides real life learning opportunities (Howell & Mordini, 2003). Kibet and Kathuri (2005) structured study in Zimbabwe to measure the influence of project work on students' performance in secondary schools. Results revealed significant difference between higher order cognitive skills and project work, (F (3, 350) = 3.217, $p < .05$). Project work enhances creativity, retention

level, conceptual understanding, and interest of students of science concepts (Colley, 2008; Petty, 2009).

Inquiry refers to process of self-learning with less teacher intervention for gathering information about phenomenon through hands-on experiences. Observing, framing questions, gathering information, predicting, reflecting, and drawing conclusions are primary elements of inquiry teaching (Crawford, 2000; Rao, 2004; Wheeler, 2000). Inquiry teaching develops students' cognitive abilities in understanding scientific concepts, higher order thinking, peer learning, decision making, investigation skills to solve daily life problems, generating new knowledge and academic skill development (Arends, 2014; Government of Pakistan, 2009; Holmes & Hwang, 2016; Mehmood & Rehman, 2011; Minner, Levy, & Century, 2010; Roehrig, Kruse & Kern, 2007; Woolfolk, 2019). Students learn physics better through inquiry that focuses on critical thinking, problem solving and logical reasoning (Dayal et al., 2007; Wheeler, 2000). Inquiry teaching improves academic excellence of students (Secker, 2002). Urban teachers have positive perception of curriculum-based inquiry teaching, but rural teachers have limited usage of inquiry teaching (Bybee, 2002; Ramnarain, 2014). Njoroge, Changeiywo and Ndirangu (2014) framed study to explore the influence of inquiry teaching on secondary school physics students. Findings revealed significant difference between teaching through inquiry and traditional methods in secondary school physics students' performance. Minner et al. (2010) structured study in USA to find out the influence of inquiry instructions on science students' learning outcomes. Data matrix design was used to collect the data from 138 studies. Findings of the study revealed that 51% showed positive trends of inquiry teaching that emphasized on learners' active thinking and conceptual understanding for drawing conclusions.

Debate refers to process of reasoning different viewpoints and arriving at conclusion (Freeley & Steinberg, 2013). Walker and Warhust (2000) claimed that 82% of students understand subject content better through debate. It is constructive teaching learning tool. Zare and Othman (2013) structured qualitative study in Malaysia to explore classroom debate as teaching learning approach. Results revealed that debate promote students' engagements, critical thinking and mastery learning of the subject content. Debate enhances students' confidence level, communication skills, critical thinking, listening and speaking abilities (Debore, 2002; Roy & Macchiette, 2005: Tessier, 2009; Zare & Othman, 2013). Achimugu (2016) framed study in Nigeria to examine the effect of curriculum implementation on a sample of randomly selected 76 teachers. Results of independent sample t-test showed no significant difference existed between teachers' locality based on curriculum implementation. Teachers working in rural schools were implementing same curriculum as compared to urban schoolteachers.

Teaching methods are key pivot and associated with curriculum implementation (Roehrig et al., 2007; Powell & Anderson, 2002). The researchers framed the study focusing curriculum based student-centered teaching methods.

Exploring the effect/relationship of students-centered teaching method is an important aspect that enhances worth of curriculum implementation. Social scientists also explored those applications of student-centered teaching methods play a catalytic role in implementing physics curriculum (Enderle, Southerland, & Grooms, 2013; Khan, Khan, & Turi, 2019; Karamustafoglu, Costu, & Ayas, 2006; Memon, 2015; Nawaz & Akbar, 2019; Owston, 2007; Rahman, Rahman, & Rahman, 2021; van Oers, 2015).

Rahman et al., (2021) framed study to explore the use of teaching methods for account subject teachers in implementing curriculum in secondary schools of Bangladesh on a sample of 25 teachers working in public sector schools. The researchers administered self-developed questionnaire consisting of 5-point Likert type options. The collected data through questionnaire and interview were analyzed calculating mean, standard deviation, frequency, percentage and applying ANOVA. Finding of the study revealed that teacher-student interactive teaching methods are effective in achieving learning outcomes of curriculum. Enderle et al., (2013) structured study to explore the effect of student-centered teaching methods on studio physics curriculum implementation in United States. The sample of the study comprised of four physics teachers, 105 observation and 44 conversations with teachers. The data collection instruments were interviews, observation, and documents. Constant comparison method was used to analyze the collected data. Findings of the study demonstrated that student-centered teaching methods influence on implementation and were aligned with classroom practices for desired learning outcomes. Karamustafoglu et al., (2006) conducted study to explore views of chemistry teachers about implementation of student-centered approaches in Turkey. A case study method was used for this research on a sample of 50 secondary teachers selected through random sampling were used to collect data through questionnaire.

The collected data were analyzed through calculating frequency and percentages. Findings of the study revealed that teachers were aware of student-centered teaching approaches but still they are using traditional instructional techniques. Khan et al., (2019) reported that less quantitative exploratory studies were conducted focusing teaching learning process. Student-centered teaching methods support holistic development of learners in a meaningful way for curriculum implementation (Nawaz & Akbar, 2019; van Oers, 2015), were limited in use in Pakistan (Mahmood, 2007; Jan, 2013). Teaching principles assist in effective teaching-learning process to enhance

learners' skills for better future. Teaching principles and classroom practices ensure effective learning that required clarity in communication, objectives, content presentation, correlation between previous and new information, learning activities and feedback (Banks, Leach, & Moon, 2005; Deng, 2007, Walsh & Wyatt, 2014). Fewer studies were conducted in Pakistani local context to examine student-centered teaching methods regarding physics curriculum implementation.

Statement of the Problem

Curriculum developers intend curriculum for schools regarding use of teaching methods for implementing curriculum. Students-centered teaching methods are key indicators that strongly influence curriculum implementation. Literature reported that student-centered teaching methods influence physics curriculum implementation (Achimugu, 2016; Karamustafoglu et al., 2006; Omwirhiren & Ibrahim, 2016), biology curriculum implementation (Taraban, Box, Myers, Pollard, & Bowen, 2007; Ugwuadu, 2012) and mathematics curriculum implementation (Achuonye, 2015; Johansson, 2003; Ramnarain, Nampota, & Schuster, 2016). There are hardly studies framed in the global and local perspectives on student-centered teaching methods physics curriculum implementation. Limited studies have been conducted regarding student-centered teaching methods (Hassan, 2020; Hassan & Akbar, 2020; Mehmood & Rehman, 2011) for physics curriculum implementation in Pakistan. Moreover, the researcher is a PhD scholar and has been teaching physics to secondary classes for eighteen years and it is his strong observation that student-centered teaching methods were less used for physics curriculum in public sector secondary schools of the Punjab. There is dire need to design a study about student-centered teaching methods for physics curriculum implementation.

Research Questions

Following research questions were focused in the current study:

1. To what extent gaps exist between intended and enacted secondary schools teaching methods?
2. To what extent secondary schools use small group discussion, project, inquiry, and debate teaching methods?

Research Methodology

Research methodology deals with the procedures and methods planned in research to obtain required outcomes. Researchers used survey technique in descriptive research design to collect data (Ahmad & Akbar, 2020; Murtaza & Akbar, 2020; Naseer & Akbar, 2020; Nawaz, 2020). Survey technique is appropriate for descriptive studies to explore specific aspect of a situation or to seek explanation of phenomenon (Kelly,

Clark, Brown, & Sitzia, 2003). In this research, the researchers applied descriptive research design to describe the actual situation of curriculum implementation practices happening in the public sector secondary schools of the Punjab province of Pakistan. The population of the study consisted of 219, 438 secondary school science students studying in public sector secondary schools of the Punjab, from which, the researchers selected sample of 2,880 respondents enrolled in 10th grade class in session 2015-2017 through multistage sampling technique to collect the data. Multistage sampling is suitable for administrative hierarchy units' stage population. Multistage sampling technique consists of three phases; multistage, stratified, and random process (Sekaran, 2000; Teddlie & Yu, 2007). Through this technique, the population is divided into strata. Then sample is selected through stratified sampling (Johnson & Christensen, 2016; Polit & Beck, 2010). The present study used multistage sampling technique to select representative sample from public sector secondary school science students from the Punjab Province of Pakistan. The current study is a part of doctoral dissertation. The researcher personally visited to approach one physics teacher from each selected public sector secondary of the Punjab.

Self-developed questionnaire was used to collect the data regarding student-centered teaching methods stated in national curriculum for physics grade IX-X 2006 (Gillham, 2000; Government of Pakistan, 2006). The questionnaire was consisted of small group discussion, project work, debate, and inquiry teaching methods of 15-items at 5-point Likert type rating options. Self-constructed instrument was validated from prominent experts in physics. Experts added and deleted few items that were not according to the cultural settings. After ensuring validity, the researchers piloted the questionnaire on small sample of the respondents of district Kasur that were not included in final collection process. The researchers calculated the Cronbach's Alpha reliability of the data; .823. After ensuring reliability of the data, final data were collected by the researchers themselves. Collected data were numbered in ascending orders; it was coded and entered in SPSS. To explore students' perceptions about teachers teaching methods, the researcher applied descriptive statistics. The researchers applied independent sample t-test (Casella & Berger, 2002; Driscoll, Lecky, & Crosby, 2002; Norusis, 2008; Richardson, 2001) to find out rural and urban students' perception on teaching methods for physics curriculum implementation.

Data Analysis and Interpretation

Data were analyzed through applying descriptive statistics and independent sample t-test in SPSS. National curriculum includes four student-centered methods for physics: small group discussion, project work, inquiry and debate teaching. Results of the research were interpreted based on mean scores.

Table 1 *Small group discussion*

Sr.	*Items*	*Students' locality*				*Overall*	
		Urban		*Rural*		*M*	*SD*
		M	*SD*	*M*	*SD*		
1	Teachers use of discussion during teaching physics	2.92	1.34	2.64	1.27	2.78	1.32
2	Teachers organize discussion for generating new ideas	3.28	1.22	2.95	1.14	3.12	1.19
3	I participate in classroom discussion for sharing ideas	3.27	1.22	3.12	1.18	3.19	1.21
4	Students give their opinions during discussion	3.49	1.17	2.95	1.16	3.23	1.20
5	Teacher guides the class in drawing conclusion by analyzing students' opinions	3.72	1.29	2.87	1.26	3.30	1.35
	Overall Mean	**3.34**		**2.91**		**3.10**	

Table 1 shows that in case of small group discussion teaching method, overall mean score of urban students was more (M = 3.34) as compared to rural students' mean score (M = 2.91). The table further reveals that urban and rural students' overall perception on the use of small group discussion method was M = 3.01. Overall, mean of discussion method was 3.10 that reflects 62% teachers use this method during physics teaching.

Table 2 *Project work*

Sr.	*Items*	*Students' locality*				*Overall*	
		Urban		*Rural*		*M*	*SD*
		M	*SD*	*M*	*SD*		
1	Assigns physics topic related projects to students	3.62	1.34	2.81	1.41	3.22	1.43
2	Interest in completing projects of Physics	4.18	1.08	3.73	1.28	3.95	1.21
3	I gain real life physics experiences through project work	3.12	1.43	3.05	1.27	3.08	1.35
	Overall Mean	**3.64**		**3.20**		**3.42**	

As delineated in Table 2, students of urban areas have more perception (M = 3.64) as compared to students of rural areas (M = 3.20). Overall students of urban and rural areas have 3.42 mean score that portrays 71.6% teachers use project work.

Table 3 *Inquiry strategy*

Sr.	*Items*	*Students' locality*				*Overall*	
		Urban		*Rural*		*M*	*SD*
		M	*SD*	*M*	*SD*		
1	Teacher gives opportunity of concepts observation	3.45	1.15	3.08	1.14	3.27	1.16
2	Teacher gives the data interpretation skills development opportunities	3.38	1.21	3.06	1.14	3.22	1.18
3	Students draw their own conclusion regarding the topic	3.54	1.23	3.04	1.18	3.28	1.23
4	Teacher assigns self-study tasks	3.12	1.43	3.05	1.27	3.08	1.34
	Overall Mean	**3.37**		**3.05**		**3.21**	

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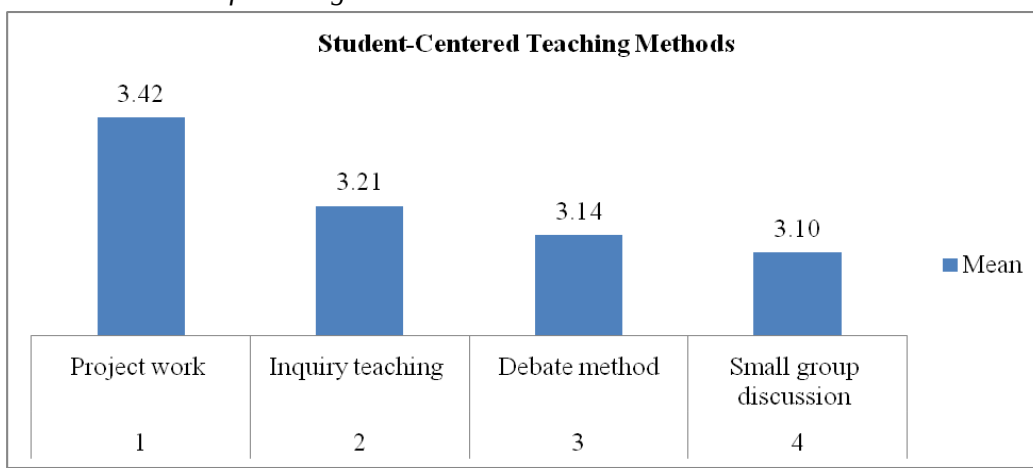
As presented in Table 3, students of the urban areas have about more perception (*M* = 3.37) as compared to students or rural areas (M = 3.05) about their teachers use of teaching methods used in the public sector schools to implement physics curriculum. Moreover, overall mean score was calculated (*M* = 3.21) that depicts 64.2% teachers use inquiry for physics curriculum implement in the public sector secondary schools of the Punjab.

Table 4 *Debate method*

Sr.	*Items*	*Locality*				*Overall*	
		Urban		*Rural*			
		M	*SD*	*M*	*SD*	*M*	*SD*
1	Teachers organizes debates on physics topics	2.67	1.28	2.60	1.67	2.64	1.36
2	Teacher provides opportunities arguing for or against given topics	2.79	1.02	2.36	.88	2.61	.98
3	I actively participate in physics classroom topics debate	4.19	0.89	4.16	1.02	4.18	0.94
	Overall Mean	**3.22**		**3.04**		**3.14**	

As presented in table 4, students at the public sector schools stated that urban schools' teachers were making more (M= 3.22) use of debate for physics curriculum implementation as compared to teachers of rural areas (M= 3.04). Furthermore, interpretation reveals that overall mean score was M= 3.14 that depics 52.8% teachers use debate during physics curriculum implementation in the public sector secondary schools of the Punjab.

Figure 1 *Mean score of teaching methods*



As established in figure 1, results of descriptive statistics revealed that teachers were making maximum use of project work (*M* = 3.42) making minimum use of small group discussion for implementing physics curriculum at secondary level schools (*M* = 3.10).

Table 6 *Teachers use of teaching methods during teaching physics*

Locality	*N*	*M*	*SD*	*Df*	*T*	*p*
Urban	1440	94.916	13.865	2878	15.234	.01
Rural	1440	87.612	11.781			

As revealed in Table 6, researchers applied independent sample t-test to find out rural and urban teachers curriculum implantation practices in the public sector secondary schools of the Punjab. Interpretation reveals significant difference between Physics curriculum implementation practices by teachers' gender, t (2878) = 15.234, $p < .05$. It is concluded that urban teachers were making more physics curriculum implementation (M = 94.916, SD = 13.865) as compared to rural public sector schools' teachers (M = 87.612, SD = 11.781).

Table 7 *Revealing Independent Sample t-test on small group discussion, project work Inquiry and debate*

No	*Teaching method*	*Locale*	*N*	*M*	*SD*	*df*	*t*	*p*
1	Small group discussion	Urban	1440	16.701	3.865	2878	15.51	.01
		Rural	1440	14.539	3.612			
2	Project work	Urban	1440	7.805	1.964	2878	16.43	.01
		Rural	1440	6.531	2.191			
3	Inquiry	Urban	1440	10.372	2.729	2878	12.24	.01
		Rural	1440	9.188	2.459			
4	Debate	Urban	1440	2.676	1.172	2878	1.80	.01
		Rural	1440	2.601	1.089			

As delineated in Table 7, the researchers run independent sample t-test on rural and urban use of small group discussion, project work, inquiry and debate method to implement national curriculum of physics working in the public sector secondary schools' teachers of the Punjab. The interpretation revealed significant difference between rural and urban teachers' use of small group discussion, project work, inquiry, and debate. Teachers working in urban schools were making more use of small group discussion, project work, inquiry and debate method as compared to teachers at rural public sector secondary schools.

Discussion

Teachers make maximum use of teaching method for effective curriculum implementation. Teaching methods are ways of sharing and interaction for exchange of knowledge. Intended curriculum is translated into enacted curriculum through the usage of suitable teaching methods (Government of Pakistan, 2006). The current study was conducted to examine up to what extent teachers were using student-centered teaching methods for effective physics curriculum implementation. The results of the current

research showed that 56% teachers were using student-centered teaching methods to implement national curriculum of physics. Furthermore, urban teachers were making more physics curriculum implementation as compared to rural public sector schools' teachers in their classroom practice in accordance with national curriculum for physics. Results of the current research declared that the Pakistani physics teachers make more use of discussion for curriculum implementation that is consistent with other studies (Achuonye, 2015; Buabeng et al., 2014; Fernandez, Ritchie, & Barker, 2008; Oguta, 2014) which show that discussion method is effectively used at secondary level for physics curriculum implementation. Results of the current study exhibited teachers' use of inquiry teaching influence on physics curriculum implementation that consistent with results of other studies (Achuonye, 2015; Minner et al., 2010; Ramnarain et al., 2016) inquiry engages learners in mental process to enhance understanding about nature of science for drawing conclusions, which are consistent with the results of the current research and other studies as well (Achuonye, 2015; Carpenter, 2006) project work involves learners in applying knowledge in the real world, which supports with the results of the current research and consistent with the results of the studies of (Barrett, 2007; Bentri, 2017) and is inconsistent with study of Dyer (2008) due to insufficiency of instructional materials, contextual conditions and high students-teacher ratio, inconsistent with the study of Dancy and Henderson (2010) due to gap between physics curriculum and classroom pedagogical practices.

Conclusion

The current study was conducted to examine student-centered teaching methods for implementation of national curriculum of physics. Small group discussion, project work, inquiry and debate are stated in national curriculum for physics. Study concluded that overall teaching methods mean was 2.8 which described that 56% student-centered teaching methods were in practice. Furthermore, small group discussion method, 62%, project work, 71.6%, inquiry, 64.2% and debate, 52.8%, were in use, for physics curriculum implementation. Results further showed that teachers working in urban schools were making more use of small group discussion, project work, inquiry and debate method as compared to teachers of rural public sector secondary schools in account of physics curriculum implementation.

Recommendations

Teachers delivered content using variety of teaching methods stated in curriculum for its effective implementation. Based on the findings and conclusions of the study, it is recommended that teachers use student-centered physics curriculum-based teaching methods for real implementation of national curriculum for physics. District education

authority provides support system and curriculum implementation materials, and Quaid-e-Azam Academy for Educational Development; QAED trains science teachers for using student-centered teaching methods during teaching physics. Head teachers ensure effective use of student-centered teaching methods stated in physics curriculum through intensify follow-up mechanism.

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