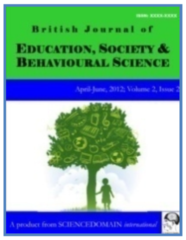

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Impact Analysis of Student Centered Inquiry Based Project and Implications on Standards of Science Curriculum in Pakistan

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Author's contribution

This paper was written by the author AQT by citing basic work in references.

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ABSTRACT

This paper aims to analyze the impact of baseline and end-line surveys in terms of its inputs and achievements during three years (2009-2012) project on "student-centered and inquiry-based (SCIB) learning" sponsored by Japan International Cooperation Agency (JICA). The activities of the project included the preparation of science lesson plans, training of master trainers, training of school science teachers, school cluster programs and organizing awareness seminars at the Federal and the Provincial levels that helped in development and continuity of science efforts being made for the implementation of science curriculum in Pakistan. For the purpose to achieve the objectives of the project, a research was designed on survey type of quantitative study. Four instruments and an observation sheet were used for data collection. The sample of the study comprised of 4501 teachers, students and observations made during survey. The data of the study is represented through graphs and a statistical examination is carried out in terms of difference-in-difference estimation. The result of the analysis advocated for an infrastructure of training of science teachers which supports in delivering the lessons effectively and making the science activities interesting. The findings of the study can be linked with implications of SCIB project on standards of science curriculum in Pakistan. The recommendation of the study underpin for improvement in identifying alternate strategies and the options for a more effective and efficient in-service teacher education model. The results of the study can help in exploring the possibilities of sharing and generating cross-cultural studies and projects in science education among other countries.

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Keywords: Impact analysis; student centered; inquiry based; standards; science curriculum; implications.

1. INTRODUCTION

The National Education Census [1] indicated that there were no content standards for curriculum as well as professional standards for in-service education of teacher in Pakistan. The science curriculum does not cater to the diverse conditions in the education sector, as well as, the variations within the geographical breadth of Pakistan [2] and meeting the goals of science education globally [3]. For this background in view, a comprehensive review of elementary science curriculum for grades 4 to 8 was initiated in 2005. The experts of National Curriculum Council reviewed the scheme of studies, drafted the elementary science curriculum after comparing with similar type of curricula of other countries. The current elementary science curriculum received the present form after exhausting a long consultative process of interaction and discussion with all stakeholders including working science teachers, administrators, educationists, curriculum experts and students [4]. The lesson learned as consequence of various studies [5,6,7,8] on teacher education for elementary school science teachers of Pakistan is the deficiency in terms of delivery through an inquiry and concept building approach [9,10,11]. In an effort to assist Pakistan to begin with a holistic review of elementary science lessons and establishing a training model for the in-service science teachers, the Japan International Cooperative Agency (JICA), Pakistan took an initiative in launching a three years project namely; "student-centered and inquiry-based (SCIB) learning". The project was mainly based on development of lesson plans of General Science Curriculum for grades 4 to 8 emphasizing the concept of student-centered and inquiry-based learning. This paper analyzes the objectives, programs and achievements followed by a base-line and end-line survey reports of the SCIB project and to look into its implications on standards of science curriculum in Pakistan.

1.1 SCIB Project

The main objective of the project was to develop a worthwhile teacher training package that motivates science teachers to use lesson plans developed on inquiry approach for implementing in Islamabad Capital Territory (ICT) in five pilot clusters of schools and in provinces of Pakistan. As an output of the project set forthwith according to JICA report [12], "the project was to: (i) develop SCIB teaching plans for grade 4-8 science; (ii) equip master trainers with skills and knowledge to use SCIB lesson plans; (iii) identify necessary interventions for effective teacher training through pilot activities in ICT; (iv) share experience of model teacher training among other educational related stakeholders and to increase their interest in SCIB". As a result of achievement of the project, the SCIB teaching plans were developed for grade 4 to 8 both in English and national language 'Urdu'. The DVDs and books of these lesson plans were distributed to the teachers of pilot cluster schools of ICT and education departments of the provinces. The teaching plans comprised of unit plan, lesson plan, subject matter, marking material and ways of assessment. One hundred ninety three master trainers were trained and equipped with science process skills and knowledge of science to deliver SCIB science lessons. These trainers were conducting training specifically in material making; lesson plans improvements and integration of concept building of science principles. The training content covered five interlinked areas focusing on the General Science Curriculum and lesson plans study in order for the participants to understand the teaching principles and methods to follow the curriculum [13] as illustrated in Fig. 1. Twenty selected officers engaged in the project were sent to Japan for training in the activities related to SCIB and in the area of management. Some important inputs for suitable teacher training were identified through pilot activities in ICT. One of the major achievements of this project was to share the experience of model SCIB teacher training among other education related stakeholders and their interest in SCIB was increased. For this, a number of forums, awareness raising meetings and promotional videos were organized in the provinces and in ICT [13].

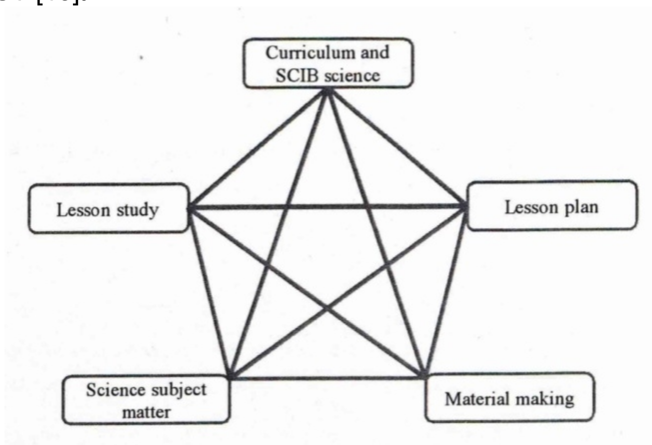

Fig. 1. Interlinked areas for teacher training of SCIB project

1.2 Standard-base Elementary Science Curriculum

The overall goal of science education set forth in Pakistan is to develop scientific literacy as a result of context-based learning related to real-world problem as defined by [14,15,16,17,18]. Therefore, science education which strives for scientific literacy is intended to focuses on inquiry-based curricula [19]. According to National Science curriculum document [20], "three basic processes used to answer these questions; scientific inquiry addresses 'Why' questions; 'How' questions are answered by engaging in the problem solving and 'should' questions are answered by engaging in decision making. The framework of elementary science curriculum provided a set of well-defined General Science Outcomes (Learning Strands and Content Standards), key stage Curriculum Outcomes (Benchmarks) and specific Curriculum Outcomes (Student's Learning Outcomes - SLOs)". The conceptual map for the curriculum outcomes is illustrated in Fig. 2 [20].

Accordingly, "six major learning areas as learning strands selected for this curriculum includes: Life Science, Physical Science, Earth and Space Science, Skills, Attitude and Science, Technology, Society and Environment (STSE). The intergraded strands are interwoven with the three contextual strands (Knowledge, skills and attitudes). The description of contextual or content strands as content standards in this curriculum outlined the subject areas into Life Science, Physical Science and Earth and Space Science. These standards embrace with the learning unit, theories, concepts, principles and practical work that are essential to an understanding of each science area [21].Benchmarks are the statements that identify the learning outcomes of students what they are expected to know, be able to do and value by the end of high schools [14]". In this curriculum, two sets of benchmarks have been selected. First, the benchmarks for the grade-cluster IV-V – what learning outcomes will be expected from all students at the end of Grade – V in the six (6) learning strands. While the second set of benchmarks is for the grade-cluster of VI-VIII – What learning outcomes will be expected from all students at the end of Grade – VIII in the six (6) learning strands? Another important component of elementary science curriculum are the Student's Learning Outcomes (SLO's) which are basically the incremental steps towards accomplishment of benchmarks organized around the standards and listed for each grade level as stated advance in their knowledge, skills, attitudes and applications.

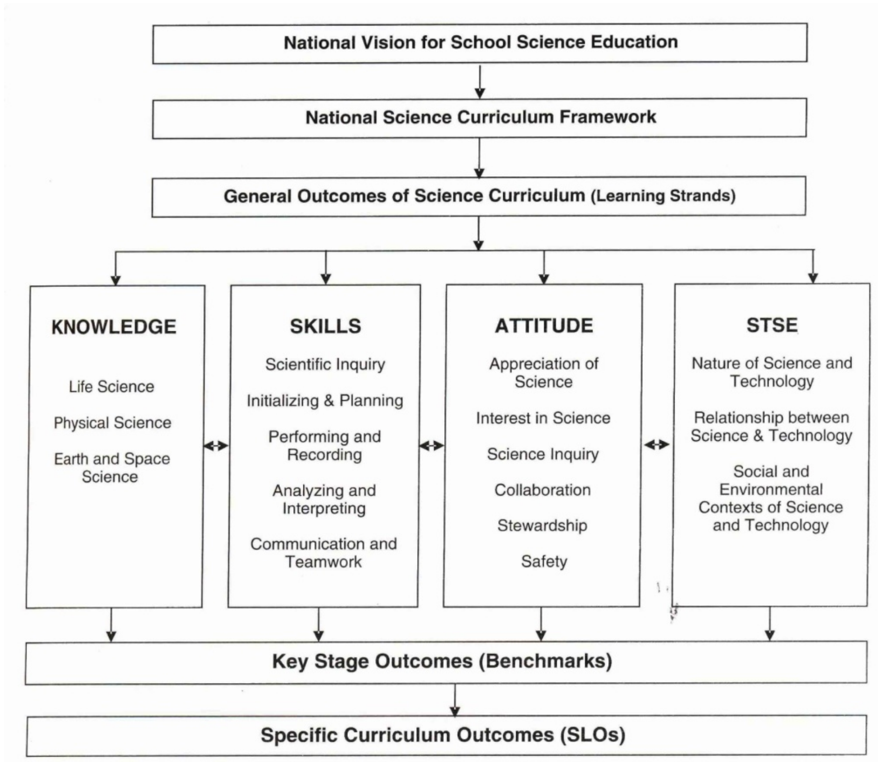

Fig. 2. Conceptual map of national science curriculum for grade 4-8

1.3 In-Service Teacher Training

The professional development of teachers goes through induction in their first year of teaching, should continue throughout their career [22]. For a system to deliver quality education, particularly in a world of changing needs and expectations, it is essential that teachers and heads of institutions have access and participate regularly and frequently in, continuing professional development or in-service education. In-service education for teachers is seen as an appropriate means of assisting the teacher to meet classroom challenges [23]. It was with this in mind that the Education Policy, 1979 [24] stated that every teacher should have the opportunity of in-service training at least once every five years. This was modified in the 1992 Education Policy [25] in which it was stated that a regular in-service program would be launched for teachers at all levels. Education Policy 2009 [26] elaborated the need of professional training of in-service teachers through a program organized on a three-year cyclic basis. The policy linked the progress in career of in-service teachers to enhancement in their capabilities and skills through training during the job. The policy specifically recommended that in-service teacher training in science subjects shall be based on real life situation use of science kit and provision of resources of training to all primary and middle schools teachers of the country. The World Bank in its report on

"Teachers Training" [27] emphasized the utility of in-service education in developing countries. An effective form of in-service education according to the report is to produce a well designed teacher's manual and to provide it to the teacher along-with the textbook. The report concludes that "There is some evidence that the effect of in-service training is strongest when it is relatively participatory and responds to the needs that teachers themselves have identified and weakest when it consists of experts telling the teachers what to know". Bhatti RA [28] and Farooq RA [29] have identified "delivery of lessons" as the main weak area of Pakistani teachers. According to [30], the present system of in-service training of teachers in Pakistan is not significantly contributing towards their professional development especially in terms of delivery of effective lessons by science teachers. The present structure for in-service education in the provinces leaves much to be desired. In the three provinces of Sindh, NWFP and Balochistan, the Bureau of Curriculum and Extension Services and in Punjab the Directorate of Staff Development have responsibility for providing in-service education for all levels, subjects and cadres of teachers. Obviously, it is not possible to expect them to reach every teacher at every level, and the organization of in-service education needs to be re-assessed especially through the experience of SCIB project

2. BASE-LINE AND END-LINE SURVEYS FOR IMPACT ANALYSIS

2.1 Objective and Research Design of the Analysis

The main objective of this analysis was to examine the impacts of the SCIB project; comparing the data collected during the base-line survey for impact analysis (BLSIA) conducted in the beginning of the project, i.e., October 2009 and those collected during the end-line survey for impact analysis (ELSIA) in October 2011 [13]. For this, a research was designed by project team [13] on survey type of quantitative study using four instruments and an observation sheet for data collection. The sample of the study comprised of 4501 teachers, students and observations made during survey. The data of impact analysis study [13] is used as secondary source for writing this paper.

2.2 Research Questions of the Analysis

Impact analysis examined the following expected impacts of the project:

1. Whether project activities improve the teacher's understanding, skills and motivation on SCIB science lessons?
2. Whether trained teachers improve the teaching-learning process of science lessons? and
3. Whether students increased their interest and motivation in pilot schools?

2.3 Indicators of the Analysis

The Table 1 shows the summary of indicators for impact analysis. The indicators were examined after collecting necessary data using questionnaires for teachers, science lesson observation sheets and questionnaires for students. The same survey instruments were used during the BLSIA and ELSIA.

2.4 Construction and Administration of Instruments

In view of some common characteristics of SCIB project and the national science curriculum, some measurable parameters [31] were identified by an experts committee on the study. Based on these parameters, four questionnaires were constructed for baseline data collection from students, teachers (trained and untrained), principals and one class observation checklist. The instruments used for this survey were combination of close-ended as well as open ended questions. Three main instruments were constructed using the Likert scale. All the instruments met the basic requirements of face validity and content validity. The reliability coefficient alpha of three instruments was found to be 0.72, 0.69, 0.75 and .7.0 respectively. The instruments were translated into national language ‘Urdu’ for the convenience of respondents and were pre-tested before field survey. In each school included and not included in the project, the students questionnaires were administrated by the enumerators, teachers interviews were conducted by the survey supervisors and Principal’s questionnaires were filled by the Assignment Manager. The observations sheets were filled in during classroom teaching of lesson plans developed by a team of SCIB project. The same instruments were used for data collection for the end-line survey after two years. A statistical computer program was used for the purpose of data tabulation and analysis. The experts interpreted their findings, drew conclusions and finally made recommendations. The detailed results and analysis carried out by study team are given in the main study. Only a few figures, tables and major findings of the original surveys conducted by APEX Consulting Pakistan [33] reported in the JICA report [13] are presented in this paper.

2.5 Sampling

The BLSIA and ELSIA were conducted in the same 52 schools consisting of 36 pilot schools and 16 control schools in ICT. On the occasion of BLSIA, 40 sample pilot schools were selected using the following criteria, in order of priority: (a) schools that have both primary (grades 1-5) and elementary (grades 6-8), (b) schools that have primary with higher priority to elementary and (c) schools that have elementary at least half in each cluster. At the same time, 12 schools were selected as control schools for the analysis. However, four sample schools were excluded from the pilot schools after the BLSIA. The four excluded schools were considered as control schools for the analysis. The questionnaires in the ELSIA were given only to the same teachers and students in the BLSIA for the purpose of using repeated test as part of the analysis. On the other hand, the same number of science lessons was observed during both surveys; complementing lessons of the missing teachers because of the transfer to the other schools or to Grades 1-3, etc. The aggregate number of samples is shown in Table 2. Grades of the students for analysis were selected considering the schedule of pilot teacher training activities in ICT. Pilot teacher training was conducted in October 2010 for primary school teachers and in October 2011 for elementary school teachers.

Therefore, during BLSIA in 2009, students in Grade 3 studied general science with trained teachers for one year. At the same time, it was less difficult to trace those students since they possibly continued attending the same primary schools that offered Grades 1-5. Grade 5 students in 2009, who were Grade 7 in 2011, were selected because their teachers attended the pilot teacher training for elementary level in October 2011. Grade 7 students in 2009 were surveyed for stationary comparison, which is not mentioned here though.

Table 1. Indicators of the impact analysis

Instrument	Indicators		Question/observation point (sub indicators)
Questionnaire for teachers	Understanding of the SCIB lesson		What is the most encourage thing in the new curriculum of general science?
	Skill for the SCIB lesson		Do you use lesson plans/teachers guide?
			Have you ever made science teaching materials for your own class?(additional)
	Motivation for the SCIB lesson		(Primary teachers only) most favorite subject area to teach?
			(Primary teachers only) least favorite subject area to teach?
			Would you like to keep learning to improve your science teaching skills?(additional)
Science lesson observation	Quality of science lesson from SCIB perspective	Material	Did teacher use: (encircle choices)
		Question	Did students ask question to their teacher?
			How many times?
			How many students?
			Example of question (for possible qualitative analysis) (additional)
		Prediction	Where students given the chance of prediction on any scientific events?
			How many times?
			Example of prediction (for possible qualitative analysis) (additional)
		Discovering	Where students given the chance of discovering on any scientific matters?
			How many times?
			Example of discovering (for possible qualitative analysis) (additional)
		Activity	Which activities of science learning did students experience in the class lesson? (select all)
Questionnaire for students	Interest and motivation		What subject at school do you like best?
			Do you like answering to teachers question in the science class?
			What question do you ask in today's science class? (yes/no for quantitative survey)
			Is science difficult to understand?

Table 2. Number of samples of BLSIA and ELSIA surveys

	BLSIA						ELSIA		
	36 pilot schools		16 control schools		Total (52 schools)		36 pilot schools	16 control schools	Total (52 schools)
	Repeated at ELSIA	Only at BLSIA	Repeated at ELSIA	Only at BLSIA	Repeated at ELSIA	Only at BLSIA			
Questionnaire for teachers	134	60	58	24	192	84	134	58	192
Science lesson observation	20	40	11	12	31	52	60	23	83
Questionnaire for students	2460	4238	798	1355	3258	5593	2460	798	3258

3. RESULTS OF THE ANALYSIS

The collected data were categorized into primary and elementary levels due to the length of the teacher's exposure to the project. Moreover, the analysis was realized based on the comparison between trained and untrained teachers for the questionnaire survey for teachers and between pilot and control schools for the lesson study observation and questionnaire survey for students. The following shows an extract of ELSIA and additional analysis using the survey data [13].

3.1 Whether the Project Activities Improved The Understanding, Skills and Motivation of Teachers on SCIB Science Lessons?

Table 3 shows the number of samples of the questionnaire survey for teachers.

Table 3. Number of samples of questionnaire surveys for teachers

	BLSIA				ELSIA			
	36 pilot schools		16 control schools	Total (52 schools	36 pilot schools		16 control schools	Total (52 schools)
	Trained	Untrained			Trained	Untrained		
Questionnaire for teachers (primary)	20	41	30	91	17	37	21	75
Questionnaire for teachers (elementary)	15	58	28	101	18	62	37	117

i) "What is the most encouraged thing in the new curriculum of General Science?"

The question prepared seven options. Among them, the "chances of student explanation to be provided" was expected to be chosen. The ratio of both trained and untrained teachers who chose the expected answer increased in ELSIA as observed in Fig. 3 and a statistical examination (difference-in-differences estimation) given in Table 4 showed a significant increase of the ratio of trained teachers with expected answer in comparison with untrained teachers ($P < .01$). Therefore, it was concluded that the teacher training implemented by the project improved teachers' understanding.

Table 4. Statistical examination of trained and untrained teachers on their Understanding

		BLSIA Trained (N = 35)			BLSIA Untrained (N=157)		
		Correct	Incorrect	Total	Correct	Incorrect	Total
ELSIA	Correct	0.03	0.46	0.49	0.06	0.19	0.25
	Incorrect	0.00	0.51	0.51	0.06	0.69	0.75
	Total	0.03	0.97	-	0.12	0.88	-

CR = 3.56 (p<0.01)

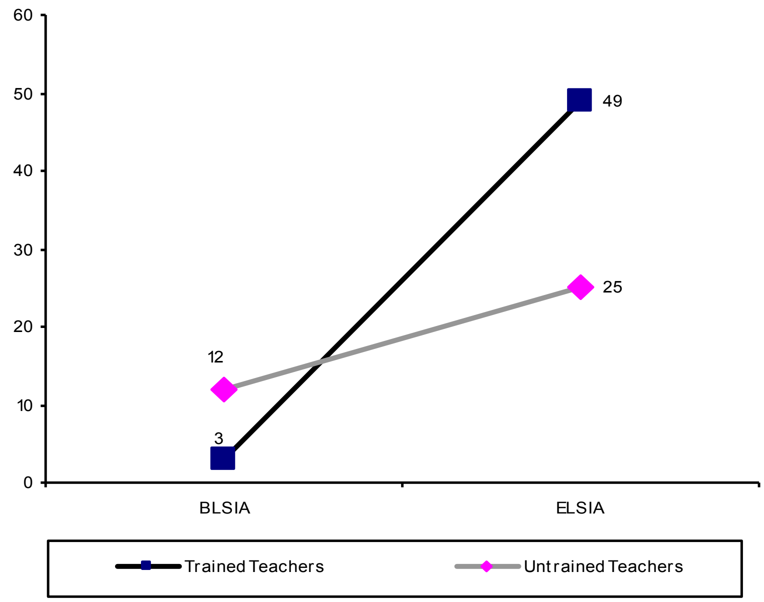

Fig. 3. Ratio of teachers who committed on most encouraged thing in the new science curriculum

ii) "Do you use lesson plans/teacher guide?"

The ratio of both trained and untrained teachers who used lesson plans/teacher's guide increased in ELSIA as observed in Fig. 4. A statistical examination (difference-in-differences estimation) given in Table 5 showed a significant increase of the ratio of the trained teachers who used lesson plans/teacher's guide compared with untrained teachers (P< .01). Therefore, it was concluded that the project's teacher training made more teachers utilize "tools" to realize SCIB science lessons. Thus, it was concluded that the project activities improved teachers' understanding and skills on SCIB science lessons.

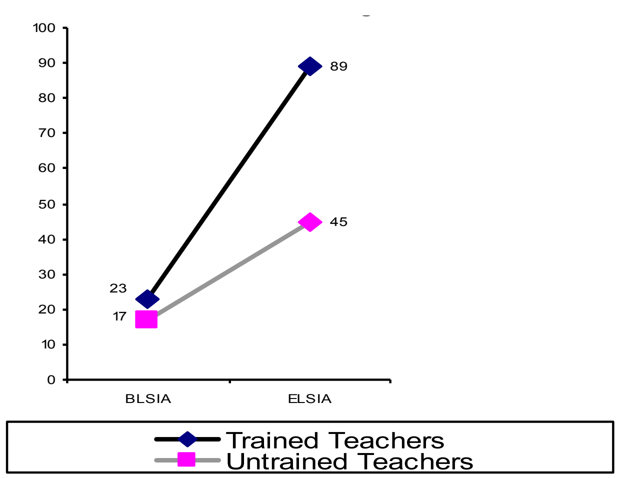

Fig. 4. Ratio of teachers who used lesson plan/teacher's guide

Table 5. Statistical examination of trained and untrained teachers on use of lesson plans

		BLSIA Trained (N = 35)			BLSIA Untrained (N=157)		
		Yes	No	Total	Yes	No	Total
ELSIA	Yes	0.23	0.66	0.89	0.10	0.35	0.45
	No	0.00	0.11	0.11	0.07	0.48	0.55
	Total	0.23	0.77	-	0.17	0.83	-

CR = 4.10 (p<0.01)

3.2 Whether Trained Teachers Improved the Teaching-Learning Process of Science Lessons?

The data were categorized into lessons at pilot schools including both trained and untrained teachers due to the lack of "trained" samples and lessons at control schools. Table 6 shows the number of samples of the lesson plans observation.

i) Were "questions by students", "chances of prediction by students" and "chances of discovery by students" observed in the lessons? — Change in each aspect between BLSJA and ELSIA.

The project considered "questions by students", "chances of prediction on any scientific event by students" and "chances of discovery on any scientific event by students" in the teaching-learning process as indicators of the quality of SCIB science lessons. In pilot schools, every indicator except "questions by students" at primary level showed improvement in ELSIA but most of them showed no significant improvement. Only "chances of prediction by students" at primary level obtained statistically significant difference between BLSIA and ELSIA (P<.01) and between pilot schools and control schools in ELSIA (P<.05) of primary and elementary levels. Accordingly, the teaching-learning process of science lessons seemed to be improving in pilot schools for both primary and elementary levels.

ii) Were questions by students chances of prediction by students and chances of discovery by students" observed in the lessons? — Number of changed aspects

The Figs. 5 and 6 shows how many of the three aforementioned aspects were practiced in science lessons by trained teachers (TT), untrained teachers in pilot schools (TP) and teachers in control schools (TC) during ELSIA in comparison with BLSIA aggregate data. At primary level, 50% of the teachers in BLSIA and less than 50% of both TP and TC practiced at least one aspect in the lesson, whereas 67% of TT practiced at least one during ELSIA among the 15 primary TT, one (7%) practiced all the aspects, three (20%) practiced two aspects, and six teachers (40%) did one aspect in their science lesson. The results at elementary level did not show a noticeable impact of the training. It should be noted again that the training for elementary teachers was not finished, yet when collecting the data for ELSIA, some factors other than the - training impact might be reflected more in the result. The statistical examination was not realized due to the lack of samples.

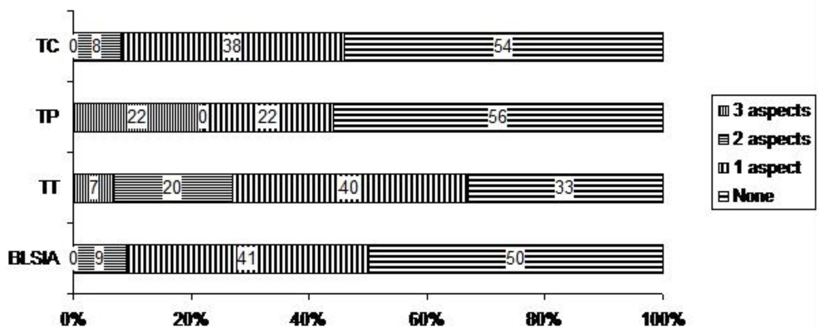

Fig. 5. Practice of three aspects in the observed lessons at primary level

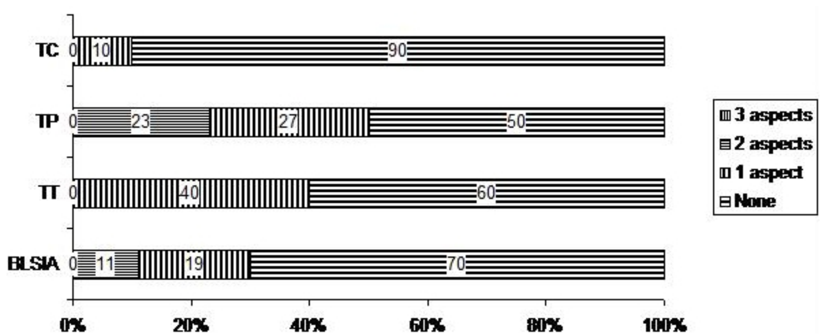

Fig. 6. Practice of three aspects in the observed lessons at elementary level

3.3 Whether students increased their interest and motivation in pilot schools?

The analysis was realized using the data of students including those who were not promoted or did not respond to the questionnaires repeatedly in BLSIA and ELSIA.

i) "What subjects at school do you like best"

Fig. 7 shows that ratio of students who said "science is the best" decreased in both pilot and control schools at primary level, i.e., one point decreased in pilot schools and 18 points decreased in control schools. A difference-in-differences estimation given in Table 7 showed statistical significance between pilot and control schools. It seemed that students in pilot schools could maintain their interest in science more than those in control schools after being promoted to a higher grade, where the content of the study was generally more complex for students.

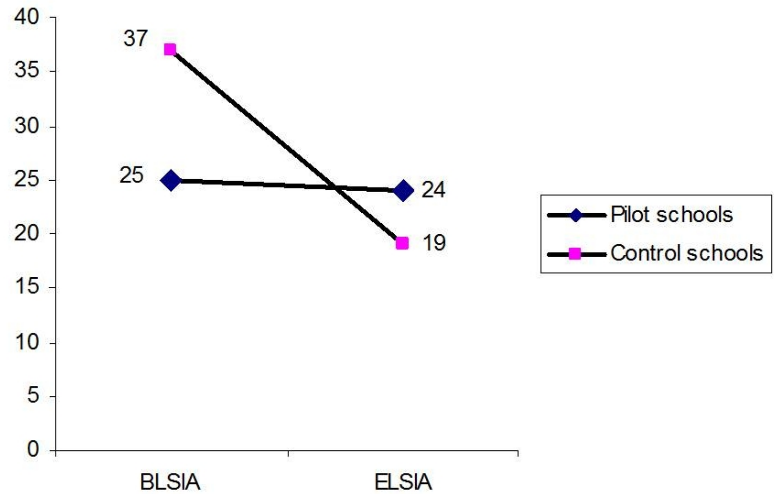

Fig. 7. Ratio of students who liked science best at primary level

On the other hand, Fig. 8 shows that the ratio of students who said “science is the best” increased in both pilot and control schools at elementary level, but there was no statistical significance between the two schools as shown in Table 8.

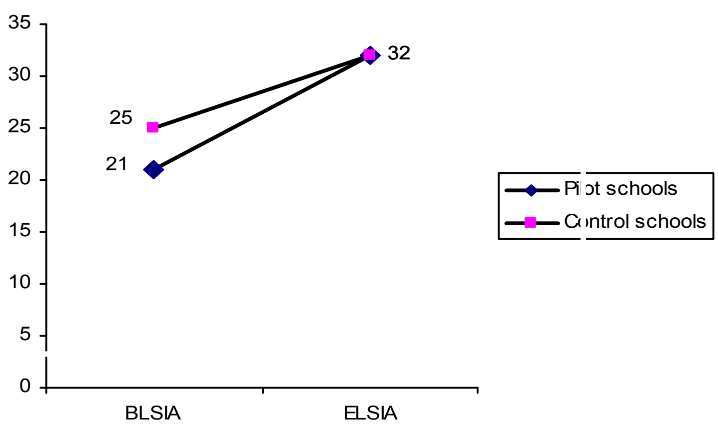

Fig. 8. Ratio of students who liked science best at elementary level

Table 6. Number of samples of the lesson plans observation

	BLSIA				ELSIA			
	36 pilot schools		16 control schools	Total (52 schools)	36 pilot schools		16 control schools	Total (52 schools)
	Trained	Untrained			Trained	Untrained		
Science lesson observation (primary)	9	24	13	46	15	18	13	46
Science lesson observation (elementary)	2	25	10	37	5	22	10	37

Table 7. Statistical examination of "science the best" between pilot and control primary schools

		BLSIA Pilot schools (N =1592)			BLSIA Control schools (N=500)		
		Science	Others	Total	Science	Others	Total
ELSIA	Science	0.07	0.17	0.24	0.08	0.11	0.19
	Others	0.18	0.58	0.76	0.28	0.52	0.81
	Total	0.25	0.75	-	0.37	0.63	-

CR = 5.48 (p<0.01)

Table 8. Statistical examination of "science the best" between pilot and control elementary schools

		BLSIA Pilot schools (N =868)			BLSIA Control schools (N=298)		
		Science	Others	Total	Science	Others	Total
ELSIA	Science	0.09	0.22	0.32	0.11	0.20	0.32
	Others	0.12	0.57	0.68	0.14	0.55	0.68
	Total	0.21	0.79	-	0.25	0.75	-

CR = 1.03 (NS)

ii) “Is science difficult to understand?”

Fig. 9 show that ratio of primary students who said “science is difficult to understand” was 20% during BLSIA but this decreased to 16% during ELSIA in pilot schools.

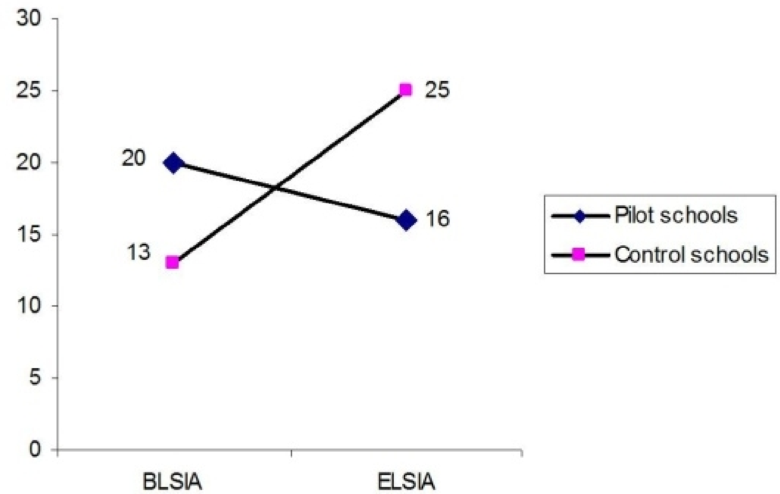

Fig. 9 Ratio of students who said science was difficult at primary level

Meanwhile, the ratio increased from 13% to 25% at control schools. The statistics estimated the difference to be significant at 1% level between pilot and control schools as given in Table 9.

Table 9. Statistical examination of “science the difficult” between pilot and control primary schools

		BLSIA Pilot schools (N =1592)			BLSIA Control schools (N=500)		
		Yes	**No**	**Total**	**Yes**	**No**	**Total**
ELSIA	Yes	0.04	0.12	0.16	0.05	0.20	0.25
	No	0.17	0.67	0.84	0.08	0.68	0.75
	Total	0.20	0.80	-	0.13	0.87	-

CR = 4.54 (p<0.01)

It seemed that students in pilot schools had less difficulty in science than those in control schools after being promoted to a higher grade where the content of the study was generally more difficult for students. On the other hand, the ratio of elementary students who said “science is difficult to understand” increased from 18% to 19% in pilot schools and decreased from 18% to 13% in control schools. Statistical estimation suggested that the difference was significant at 5% level as shown in Table 10.

Consequently, it was concluded that students increased their interest and motivation in pilot schools at the primary level. However, no improvement was observed at the elementary level. Instead, one sub-indicator suggested the presence of more motivated students in control schools.

Table 10. Statistical examination of "science the difficult" between pilot and control elementary schools

		BLSIA Pilot schools (N =868)			BLSIA Control schools (N=298)		
		Yes	**No**	**Total**	**Yes**	**No**	**Total**
ELSIA	Yes	0.05	0.14	0.19	0.04	0.09	0.13
	No	0.13	0.68	0.81	0.14	0.72	0.87
	Total	0.18	0.82	-	0.18	0.82	-

CR = 1.83 (p<0.05)

4. CONCLUSIONS AND DISCUSSION

The impact analysis concluded that the teacher training implemented by the project improved the understanding and skills of teachers to realize SCIB science lessons but the improvement of the teaching-learning process was partial, i.e., only "chances of prediction on any scientific event by students" was increased at the primary level. It was considered as a reflection of the length of exposure of teachers, i.e., teacher training for primary teachers was terminated only one year before the ELSIA, and the training program for elementary teachers had not been completed at the time of the survey. As for the project's impact on students, an increase in interest and motivation was observed at the primary level but not at the elementary level. This could be due to 1) the length of teachers' exposure to the project, 2) lack of teachers' experience in lesson study, 3) necessity of higher grade students to rote and memorize contents because of the nature of the exams, etc. The positive results observed in control schools were considered a product of any elements other than the project activities. The SCIB project met this expectation to some extent and results of the study shows that handsome stakeholders of the in-service teacher training programs of the country have received awareness. The basic purpose of the SCIB project was to conceive a framework of science's teacher training and using this in its true spirit at federal and provincial level in Pakistan. According to [32], "the training model that ensures teachers to deliver SCIB science lessons is established – refers training package including training system, method, contents, its effectiveness, challenges and lessons learned derived from the experience in the five clusters in ICT". The end-line survey specifically analyzed the project activities and training program based on (1) questioning from students as well as from teachers, (2) predicting science phenomena and events and (3) discovering science through activities and projects. However, these surveys did not include the methodology and assessment components of the training imparted to the science teachers. The real test of the material and the model developed under the project will come when this will be disseminated and implemented in the typical schools in the provinces.

5. IMPLICATIONS OF SCIB PROJECT ON STANDARDS OF SCIENCE CURRICULUM

The results of impact surveys can be articulated towards quality of science education in Pakistan. It is now desired to expand and develop a regular infrastructure which ensures the sustainability and continuity of efforts for the achievements of benchmarks and standards described in science curriculum. The stakeholders involved in the SCIB project especially the science teachers who received training under the project may play a leading role towards professional development of in-service education of teachers. According to national education census, 2005 [1] only 60 % of education is covered in public sector and remaining 40% is shared by NGOs and private sector of Pakistan. The SCIB project focused on

Government sector and only a few awareness seminars were organized for others to familiar with the project activities. As a matter of facts, the standard-base science curriculum is equally applicable for non-public sector. The activities and programs of SCIB project are therefore to be disseminated to private sector as part of a crash program through training, delivery and use of lessons and activities. It would be therefore an ideal if the teacher training is imparted by mentors/master trainers providing each union council with a Teacher's Training Center. For the achievement of benchmarks set in new science curriculum [20], it looks quite appropriate to identify some core professional standards for science teachers as well. The curriculum of teacher education and training has never been remained a part of regular exercise parallel to revision of national curriculum for students in Pakistan. This is perhaps a first attempt to focus on this particular area leading towards quality of science education in Pakistan.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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