Ministry of Education, Youth and Sports
Kingdom of Cambodia

Kingdom of Cambodia
The Project for Educational Resource Development in Science and Mathematics at the Lower Secondary Level

Project Completion Report

May 2016

JAPAN INTERNATIONAL COOPERATION AGENCY

PADECO Co., Ltd.

HM
JR
16-034

Exchange Rate: 1 Riel= ¥0.028870
1 Dollar= ¥ 113.393
(JICA Official Rate: as of April, 2016)

Contents

List of Tables

List of Figures

Appendices

Abbreviations and Acronyms

ADB	Asian Development Bank
BETT	Basic Education and Teacher Training
DCD	Department of Curriculum Development
DGE	Directorate General of Education
DPs	Development Partners
ESP	Education Strategic Plan
GSED	Seneral Secondary Education Department
INSET	In-Service Training
JCC	Joint Coordination Committee
JOCV	Japan Overseas Cooperation Volunteer
MoEYS	Ministry of Education, Youth and Sports
NIE	National Institute of Education
PDM	Project Design Matrix
POE	Provincial Office of Education
PTTC	Provincial Teacher Training College
RTTC	Regional Teacher Training Centre
SEAL	Science, Environment, Agriculture, Life skills
STEPSAM1	Secondary School Teacher Training Project in Science and Mathematics
STEPSAM2	Science Teacher Education Project
Sub-TWG	Sub Technical Working Group
SV	Senior Volunteer (JICA)
TGL	Technical Group Leader
TPAP	Teacher Policy Action Plan
TTD	Teacher Training Department
VSO	Voluntary Service Overseas
VVOB	Vlaamse Verenigin voor Ontwikkelingshulp en Technische Overseas/ Flemish Association for Development Cooperation and Technical Assistance
WG	Working Group

1. Overview

1.1 Background of the Project

In Cambodia, the human resource development system was totally destroyed by the abolishment of the Cambodian education system and purge of Cambodian intellects, both of which were the policies of the Pol Pot regime in late 1970s. After the Pol Pot regime, the education system has been restored by rapid improvements in the quantity of educational opportunities. However, some qualitative problems still remain, such as the high repetition rate and drop-outs, lack of qualified teachers, etc. In the case of the education system at the lower secondary level, the net enrollment rate from 2009 to 2010 was as low as 32.6%[1], and the drop-out rate was as high as 18.8%. Therefore, it is imperative to continue to improve the quality of education, particularly, in the areas of science and mathematics, in order to develop the required qualified human resources, in response to the industrial advancement in the near future.

In this setting, capacity building of trainers of Regional Teacher Training Centres (RTTCs), which are located in 6 provinces (Phnom Penh, Kampong Cham, Kandal, Takeo, Prey Veng and Battambang), have been more and more crucial, not only for the enhancement of teacher training, but also for the improvement of the quality of in-service teachers.

JICA has been a key partner in the efforts to improve educational quality in Cambodia. From 2000 to 2005, JICA supported the development of qualified teachers, and teacher training in science and mathematics education at the high school level through Secondary School Teacher Training Project in Science and Mathematics, which was called STEPSAM1. From 2008 to 2012, STEPSAM2 (Science Teacher Education Project) supported quality improvement of teacher training in science at Provincial Teacher Training Colleges (PTTCs) and at RTTCs, as well as the pilot in-service training (INSET).

Through the pilot INSET of STEPSAM2, the Government of Cambodia identified the high needs of further training for in-service teachers, and requested continuous support from JICA to enhance educational resources by developing Teacher's Guide and strengthening the capacity of RTTC trainers for further improvement of teacher education and teacher training.

1.2 Project Title

English title of the Project was named "The Project for Educational Resource Development in Science and Mathematics at the Lower Secondary Level," and called STEPSAM3.

STEPSAM3 is essentially different from the above-mentioned projects neither STEPSAM1 nor STEPSAM2. However, it was agreed that STEPSAM3 to be used as an abbreviation for the Project since "STEPSAM" is very well recognized and enjoys good reputation in Cambodia.

[1] Source: Cambodia National Strategic Education Plan (The figure from 2009 - 2010)

1.3 Framework of the Project

1.3.1 Project Purpose

The project purposes and outputs as well as corresponding indicators are shown below.

Table 1-1 Project Purpose

<Super Goal>	＜Indicators＞
Student achievement in science and mathematics at the lower secondary level is improved.	Student achievement in standard curriculum on Grade 9 mathematics and science
<Overall Goal>	＜Indicators＞
The educational resources developed by the Project are disseminated to other areas through training programmes conducted by MoEYS.	1. Status of the use of developed Teacher's Guide 2. Performance of training programmes implemented by RTTC trainers
＜Project Purposes＞	＜Indicators＞
Foundation for MoEYS to support teachers for science and mathematics lesson improvement at the lower secondary level is strengthened.	1. Teacher's Guide for science and mathematics lesson improvement at the lower secondary level is approved by MoEYS. 2. In-service training contents to introduce Teacher's Guide to lower secondary science and mathematics teachers is approved by MoEYS.
＜Outputs＞	＜Indicators＞
1. Teacher's Guide for science and mathematics lesson improvement at the lower secondary level is developed.	1-1. Developed Teacher's Guide 1-2.Improvement in teaching at the cooperative schools for chapters where Teacher's Guide covers: More than 60% of teachers show positive changes in more than 60% of viewpoints.
2. The capacity of RTTC trainers for science and mathematics lesson improvement at the lower secondary level is enhanced.	2-1.Evaluation of RTTC trainers on in-service training 2-2.Changes in participants' attitude toward lesson improvement through in-service training programmes

1.3.2 Changes of the PDM

Project Design Matrix (PDM) was revised once at the Joint Coordination Committee (JCC) on 11 August 2015. Points of revision are as summarized below. PDM1 and PDM2 are attached in the Appendix 1 and Appendix 2, respectively.

1. Extend the Project end from "March 2016" to "May 2016"
2. Quantitative target of super goal was eliminated as Education Strategic Plan (ESP) 2014-2018 also no more mentions the qualitative target
3. Indicator 1-2 was revised from "Improvement of student achievement at the cooperative schools for chapters where Teacher's Guide covers (From X% to Y%)" to "Improvement in teaching at the cooperative schools for chapters where Teacher's Guide covers: More than 60% of teachers show positive changes in more than 60% of viewpoints."
4. "End line survey results and other monitoring results" was settled as a mean of verification for indicator 1-2.
5. Mean of verification for indicator 2-1 was changed from "Observation sheets developed by the Project" to "Capacity Development check-list and Observation sheet developed by the project."
6. Subject of the indicator 2-2 was clearly settled as "participants."

7. Activity 1-6 was revised from "The impact of Teacher's Guide on student achievement is measured at the cooperative schools." to "Changes in the ways of teaching are monitored."
8. Activity 1-7 "The students' level of understanding is monitored." was added.

1.3.3 Counterparts and Beneficiaries

Counterparts and beneficiaries of the Project are as listed below.

Table 1-2 Counterparts and Beneficiaries of the Project

Relevant Ministry	Ministry of Education, Youth and Sports (MoEYS)	
Counterpart Organizations	Relevant departments	Directorate General of Education (DGE) Department of Planning (DoP) Department of Finance (DoF)
	Working Group	Teacher Training Department (TTD) Department of Curriculum Department (DCD) General Secondary Education Department (GSED) Regional Teacher Training Center (RTTC) trainers
Beneficiaries	Direct	All RTTC trainers of science & mathematics in six RTTCs Lower secondary science & mathematics teachers in the target provinces
	Indirect	RTTC science & mathematics trainees Students in all of the lower secondary schools in the target provinces

1.3.4 JICA Project Team

JICA Project Team was formed by 10 Japanese members in the first year of the Project, and 11 Japanese members in the second year of the Project. List of the members are as listed below.

Table 1-3 JICA Project Team: 1st Year

	Title	Name	Responsibility
1	Team Leader /Math Advisor	Koji Takahashi	Supervise the whole project activities. Develop the draft of math Teacher's Guide.
2	Sub-team Leader /Policy Advisor	Naoko Kitadate	Assist team leader to supervise the whole project activities, Advise on the Policy, Donor coordination.
3	Biology Advisor	Koichi Morimoto	Develop the draft of biology Teacher's Guide.
4	Physics Advisor	Masao Ando	Develop the draft of physics Teacher's Guide.
5	Chemistry Advisor	Masakazu Kita	Develop the draft of chemistry Teacher's Guide.
6	ES Advisor	Yasushi Sakakibara	Develop the draft of ES Teacher's Guide.
7	Science Advisor	Kenji Ohara	Coordination between JICA project team and NIE trainers for Teacher's Guide development
8	Monitoring and Evaluation Specialist	Ryuichi Sugiyama	Analysis of the baseline survey, impact survey, and end line survey
9		Kaori Tanaka	
10	Project coordinator /Training Advisor	Kanae Kawashima	Plan and supervise INSET, Supervise the sub-contractors, Administration of the project

Table 1-4 JICA Project Team: 2nd Year

	Title	Name	Responsibility
1	Team Leader /Math Advisor	Koji Takahashi	Supervise the whole project activities. Develop the draft of math Teacher's Guide.
2	Sub-team Leader /Policy Advisor	Naoko Kitadate	Assist team leader to supervise the whole project activities, Advise on the Policy, Donor coordination.
3	Math Advisor	Masashi Suzuki	Develop the draft of math Teacher's Guide.
4	Biology Advisor	Koichi Morimoto	Develop the draft of biology Teacher's Guide.
5	Physics Advisor	Kenji Ohara	Develop the draft of physics Teacher's Guide.
6	Chemistry Advisor	Masakazu Kita	Develop the draft of chemistry Teacher's Guide.
7	ES Advisor	Yasushi Sakakibara	Develop the draft of ES Teacher's Guide.
8	Science Advisor	Shinsuke Asamizu	Coordination between JICA project team and NIE trainers for Teacher's Guide development
9	Monitoring and Evaluation Specialist	Ryuichi Sugiyama	Analysis of the baseline survey, impact survey, and end line survey
10		Kaori Tanaka	
11	Project coordinator /Training Advisor	Kanae Kawashima	Plan and supervise INSET, Supervise the sub-contractors, Administration of the project

1.3.5 Implementation Structure

The Project was implemented under the responsibility of Ministry of Education, Youth and Sports (MoEYS), directed by H.E Nath Bunroeun. Joint Coordination Committee (JCC) supervised the project implementation, and the progress of the Project was reported at Sub Technical Working Group (Sub-TWG), where MoEYS and Developing Partners (DPs), including JICA, discuss on the issues related to teacher education. TTD supervised the whole project activities, and TTD staff members, DCD, GSED, and mathematics and science trainers of RTTC formed Working Group (WG) for each subject. Additionally, TTD assigned two project coordinators for coordinating with relevant departments of MoEYS, six Provincial office of Education (POE) and six RTTCs, and for facilitating WG seminars and school director meetings. POEs communicated with lower secondary schools in target provinces, by closely working with the Project.

JCC members were as listed below;

1. Secretary of State, MoEYS (Project Director)
2. Director General, DGE, MoEYS (Project Manager)
3. Deputy Director General in charge of teacher education, DGE, MoEYS
4. Director, TTD, MoEYS
5. Director, DCD, MoEYS
6. Director, GSED, MoEYS
7. Director, Department of Planning, MoEYS
8. Director, Department of Finance, MoEYS
9. Representatives from JICA

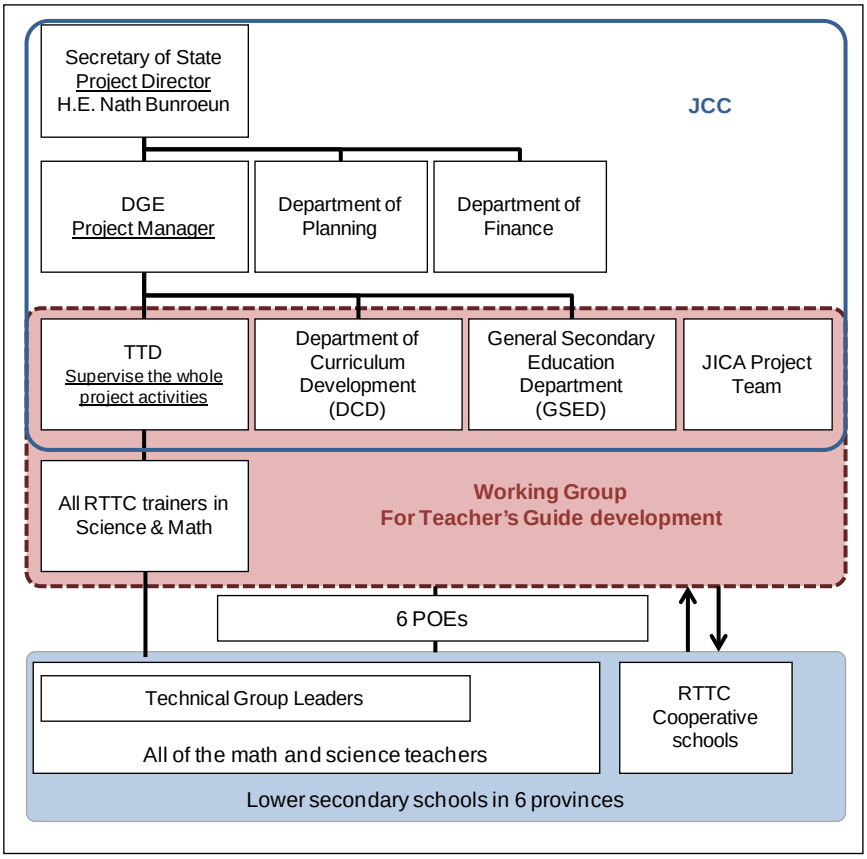


Figure 1-1 Implementation Structure

1.3.6 Target Area

The Project targeted 6 provinces, Phnom Penh, Kandal, Takeo, Prey Veng, Kampong Cham, Battambang, where RTTCs are located. As these provinces are highly populated, the number of schools with grades 7 to 9 in these provinces accounts for 40.3% of the whole kingdom, and the number of lower secondary students accounts for 43.2% according to EMIS 2014/15. Therefore, the number of lower secondary science and mathematics teachers in the target provinces is estimated to be between 40% and 50 % of the whole.

As Tbong Khmum province was separated from Kampong Cham province in the end of 2013, lower secondary schools in Tbong Khmum province were also excluded from the project's coverage. The Project's coverage rate above was thus higher until Tbong Khmum was separated.

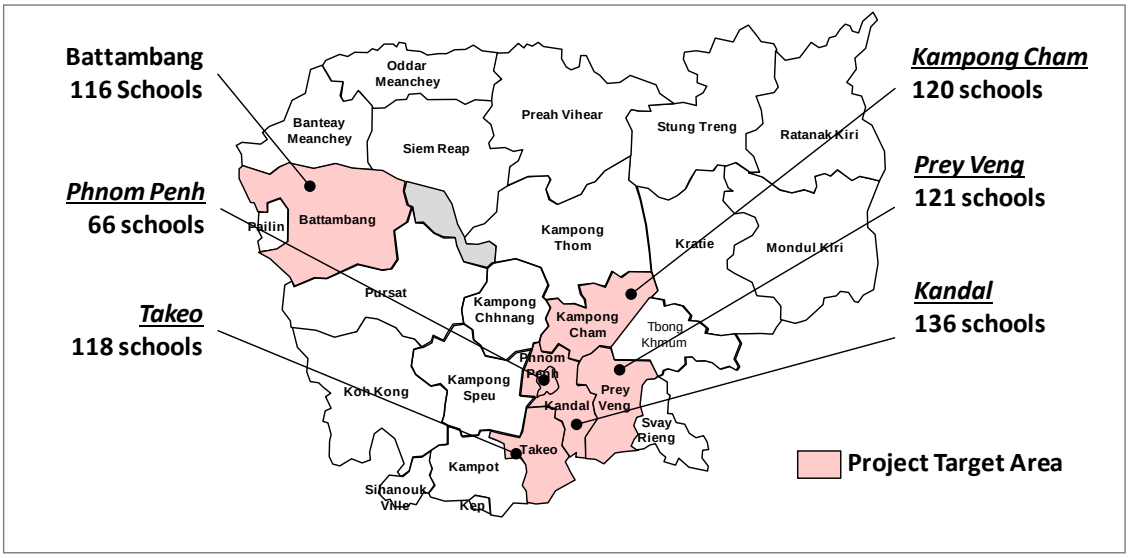


Figure 1-2 Project Target Area

1.4 Approach of the Project

The Project was designed to enhance the educational resources in Cambodia, by developing Teacher's Guide for mathematics and science lesson improvement at lower secondary level and by enhancing the capacity of RTTC trainers for mathematics and science lesson improvement at the lower secondary level. For the Teacher's Guide development, the Project established a following Activity Cycle by PDCA (Plan-Do-Check-Action); develop the draft of Teacher's Guide – use the draft of Teacher's Guide at schools on a trial basis - monitor the use of the Teacher's Guide – revise the Teacher's Guide based on the monitoring results), and the Project implemented the same Activity Cycle five times. At the same time, RTTC trainers' capacity was enhanced by continuous experiences of teaching at in-service training (INSET) through the five Activity Cycles.

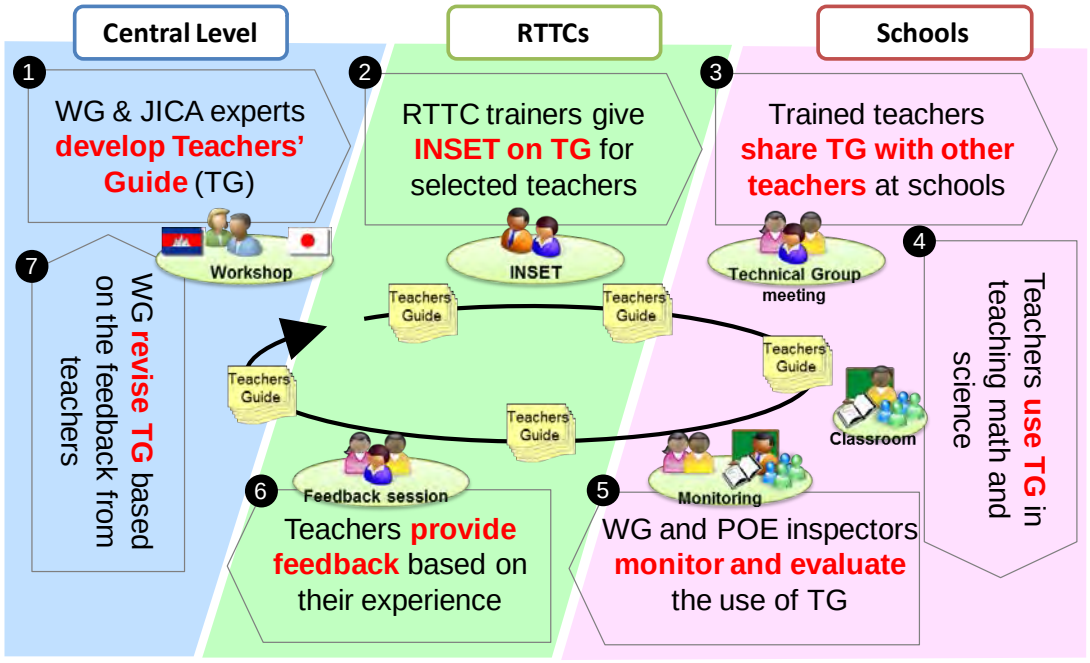


Figure 1-3 Activity Cycle

1.5 Flow of the Activity

The Project was launched in June 2013 and implemented for three years until May 2016. 1st year of the Project was from June 2013 to May 2014, and the 2nd year of the Project was from July 2014 to May 2016, respectively. During three years of the project period, the Project implemented the Activity Cycles five times. At the ending of the project, Teacher's Guide was finalized and approved by MoEYS, and the Project distributed Teacher's Guide. The flow of the activity is described in the Figure in the next page.

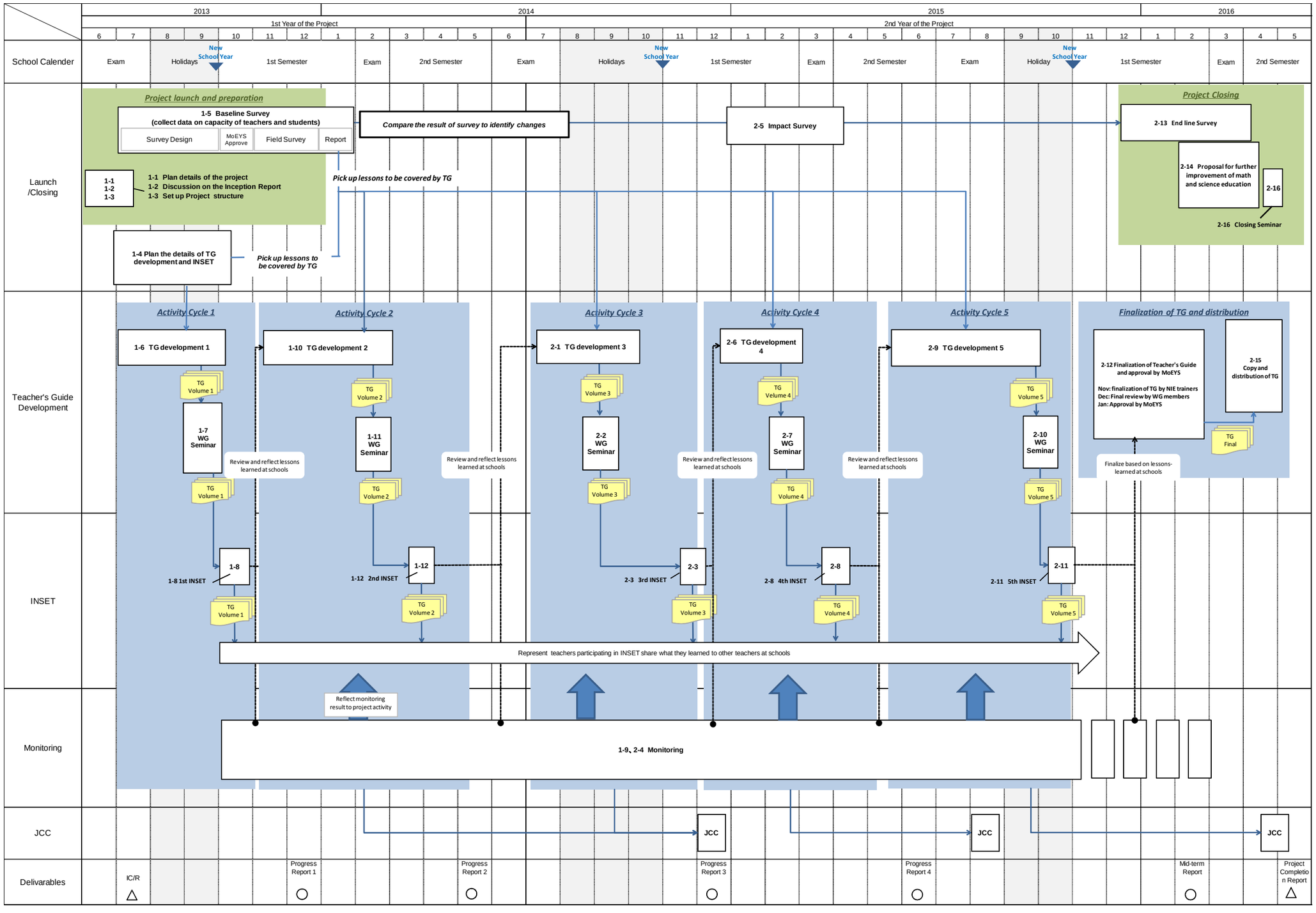


Figure 1-4 Flow of the Activity

2. Inputs

2.1 Summary of the Inputs

Inputs from Japan and Cambodia are as summarized below.

	実績
Japan	**Short-term experts: 85.85 person-months dispatched in total** Team Leader/Math Advisor 1, Sub-Team Leader/Policy Advisor, Math Advisor 2, Biology Advisor, Physics Advisor, Chemistry Advisor, Earth Science Advisor, Science Advisor, Monitoring and Evaluation 1, Monitoring and Evaluation 2, Project Coordinator/Training Advisor
	Equipments: equivalent to USD14,635.35[2] was provided in total Laptop computers, a printer, a copy machine, etc
	Local costs: equivalent to USD1,926,190.15[3] was provided in total Training expenses (allowance, accommodation, materials, etc), Copy of Teacher's Guide, sub-contract fee for Teacher's Guide development, sub-contract fee for training administration, sub-contract fee for surveys, etc
Cambodia	**Counterparts** Project management: Secretary of state, Director General of DGE, Director of TTD Project coordination: 2 project coordinators from TTD Working Group: 6 TTD staff members, 5 DCD staff members, 4 GSED staff members Approx. 80 RTTC trainers of mathematics and science POE from 6 target provinces: Directors, inspectors, and secondary officers
	Venue and facilities Project office and facilities Training and seminar venues and facilities
	Local costs Cost for electricity and water

2.2 Inputs of Human Resources

2.2.1 Inputs from JICA Project Team

A total of 12 short-term experts were dispatched for 85.85 person-months (including travel days) in Cambodia, and for 15.35 person-months out of Cambodia. Thus the total input of JICA Project Team was 101.2 person-months as shown in the Tables below.

[2] JPY was converted into USD by the using the official exchange rate of JICA as of April 2016. 1USD=113.393JPY.
[3] As this report is written before the project completes, the total cost includes some estimation. The amount of USD was calculated from the total expense of Japanese Yen in the first year of the project and the second year of the project respectively, by using the official exchange rate of JICA.

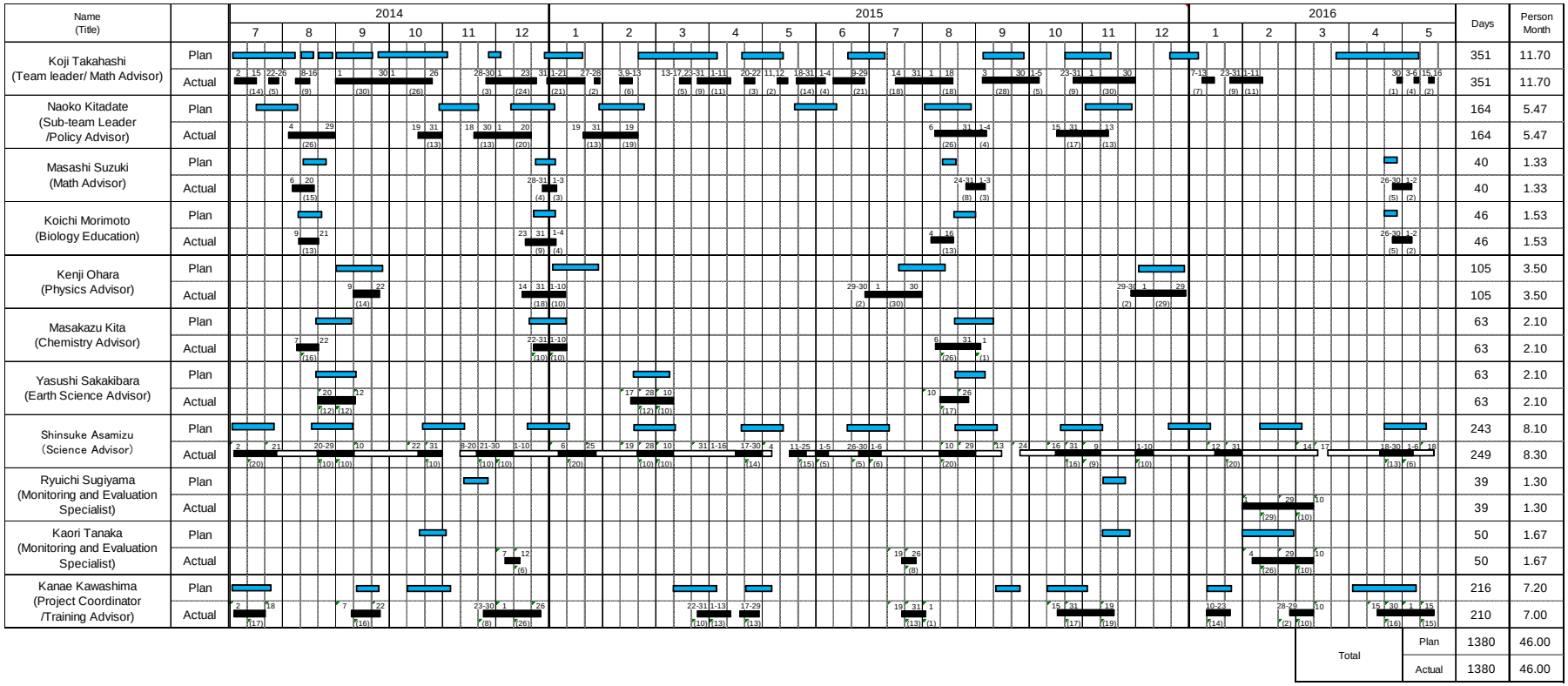
Table 2-1 Person-Month Dispatched to Cambodia : 1st Year of the Project

Name (Title)		2013 6	7	8	9	10	11	12	2014 1	2	3	4	5	6	Days	Person Month
Koji Takahashi (Team leader/ Math Advisor)	Plan														192	6.40
	Actual	30 (23)	22	5 (59)	2	8 (16)	23 11-19 (9)	27 4 (8)	30 (24)	22 10-12 (3)	3-7 (5)	17 (26)	11 20 (19)	8	192	6.40
Naoko Kitadate (Sub-team Leader /Policy Advisor)	Plan														120	4.00
	Actual	21 (18)	7	28 (26)	22	1 (34)	3	27 (33)	28	21	29 (9)				120	4.00
Koichi Morimoto (Biology Education)	Plan														30	1.00
	Actual	1 (17)	17	23 (13)	4										30	1.00
Masao Ando (Physics Advisor)	Plan														42	1.40
	Actual	12 (30)	10	25 (12)	5										42	1.40
Masakazu Kita (Chemistry Advisor)	Plan														27	0.90
	Actual	8 (8)	15	22 (19)	9										27	0.90
Yasushi Sakakibara (Earth Science Advisor)	Plan														42	1.40
	Actual	20 (18)	6	15 (24)	10										42	1.40
Kenji Ohara (Science Advisor)	Plan														90	3.00
	Actual	16 (26)	10	2 (33)	4	12 (10)	21	2 (21)	22						90	3.00
Ryuichi Sugiyama (Monitoring and Evaluation Specialist)	Plan														45	1.50
	Actual	19 (30)	18												30	1.00
Kaori Tanaka (Monitoring and Evaluation Specialist)	Plan														15	0.50
	Actual	1 (15)	15												15	0.50
Kanae Kawashima (Project Coordinator /Training Advisor)	Plan														147	4.90
	Actual	30 (35)	3	16 (17)	2	8 (33)	9		26 (28)	22	30 (16)	14 23 (18)	10		147	4.90
Total														Plan	750	25.00
														Actual	735	24.50

Table 2-2 Person-Month out of Cambodia: 1st Year of the Project

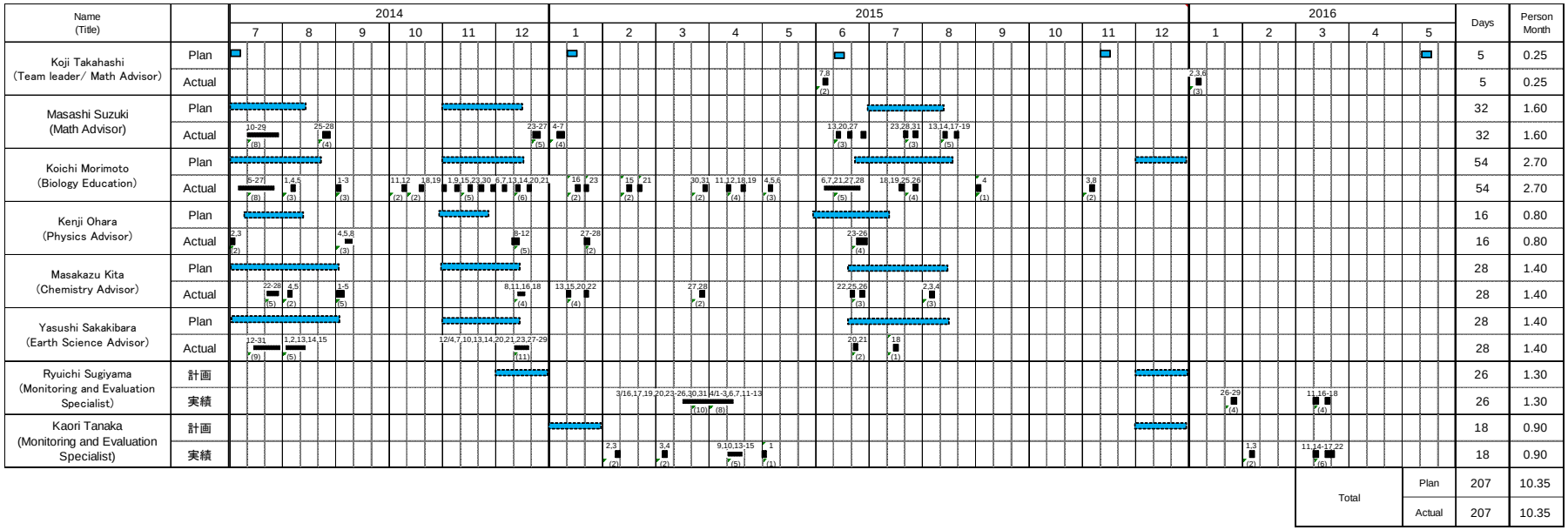
Name (Title)		2013 6	7	8	9	10	11	12	2014 1	2	3	4	5	6	Days	Person Month
Koji Takahashi (Team leader/ Math Advisor)	Plan														2	0.10
	Actual						25 (1)						12 (1)		2	0.10
Koichi Morimoto (Biology Education)	Plan														40	2.00
	Actual	28 (1)	5 (9)	28 2 (10)	26	29 (1)	2 (1)	30 (1)	1,8,19,22 (4)	16,17 (2)	4,13,24 (3)	3-24 (6)	8,15 (2)		40	2.00
Masao Ando (Physics Advisor)	Plan														12	0.60
	Actual			2-9 (6)					7-10,14,15 (6)						12	0.60
Masakazu Kita (Chemistry Advisor)	Plan														22	1.10
	Actual	27,28 (2)	6-28 (8)	3-31 (6)							17-19,24-26 (6)				22	1.10
Yasushi Sakakibara (Earth Science Advisor)	Plan														12	0.60
	Actual	25 (1)	20-30 (5)					15,16,23,27-29 (6)							12	0.60
Ryuichi Sugiyama (Monitoring and Evaluation Specialist)	Plan														0	0.00
	Actual								1/9,10,15-17,22-24,29,30 (10)						10	0.50
Kanae Kawashima (Project Coordinator /Training Advisor)	Plan														2	0.10
	Actual						25 (1)						13 (1)		2	0.10
Total	Plan														90	4.50
	Actual														100	5.00

Table 2-3 Person-Month Dispatched to Cambodia : 2nd Year of the Project



Name (Title)		Days	Person Month
Koji Takahashi (Team leader/ Math Advisor)	Plan	351	11.70
	Actual	351	11.70
Naoko Kitadate (Sub-team Leader /Policy Advisor)	Plan	164	5.47
	Actual	164	5.47
Masashi Suzuki (Math Advisor)	Plan	40	1.33
	Actual	40	1.33
Koichi Morimoto (Biology Education)	Plan	46	1.53
	Actual	46	1.53
Kenji Ohara (Physics Advisor)	Plan	105	3.50
	Actual	105	3.50
Masakazu Kita (Chemistry Advisor)	Plan	63	2.10
	Actual	63	2.10
Yasushi Sakakibara (Earth Science Advisor)	Plan	63	2.10
	Actual	63	2.10
Shinsuke Asamizu (Science Advisor)	Plan	243	8.10
	Actual	249	8.30
Ryuichi Sugiyama (Monitoring and Evaluation Specialist)	Plan	39	1.30
	Actual	39	1.30
Kaori Tanaka (Monitoring and Evaluation Specialist)	Plan	50	1.67
	Actual	50	1.67
Kanae Kawashima (Project Coordinator /Training Advisor)	Plan	216	7.20
	Actual	210	7.00
Total	Plan	1380	46.00
	Actual	1380	46.00

Table 2-4 Person-Month out of Cambodia: 2nd Year of the Project



2.2.2 Working Group

Members of the Working Group (WG) are as listed below.

Table 2-5 Working Group Members

Subject	WG members
Physics	・ Men Vannary (TTD) ・ Danh Sophy (DCD) ・ All RTTC trainers of Physics ・ Ngor Penglong (NIE)/Khek Samnang (NIE) ・ Msao Ando (JICA Project Team) – 1st year ・ Kenji Ohara (JICA Project Team) – 2nd year
Chemistry	・ Tong Rozeth (TTD) ・ Ung Sokha (DCD) ・ Bun Cheansiphal (GSED) ・ All RTTC trainers of Chemistry ・ Set Seng (NIE) ・ Masakazu Kita (JICA Project Team)
Biology	・ Eang Senglim (TTD) ・ Hou Chansara (DCD) ・ Hun Sopha (GSED) ・ All RTTC trainers of Biology ・ Hour Khim (NIE) ・ Koichi Morimoto (JICA Project Team)
Earth Science	・ Peng Bunthan (TTD) ・ Sok Vuthy (DCD) ・ Nareth Polyvine (GSED) ・ All RTTC trainers of Earth Science ・ Peng Tithsothy (NIE) ・ Yasushi Sakakibara (JICA Project Team)
Mathematics	・ Nop Sroy (TTD) /Heng Sok Leak (TTD) ・ Prum Nguon (DCD) ・ Douch Makara (GSED) ・ All RTTC trainers of Mathematics ・ Thai Heng (NIE) ・ Koji Takahashi (JICA Project Team) ・ Masashi Suzuki (JICA Project Team)

2.3 Local Cost

Local cost spent by the JICA Project Team is as listed below. As this report is written before the Project completion, the amount of the local cost of the 2nd year includes some estimation.

	Expense		Sub-contract fee	
	JPY	USD	JPY	USD(*3)
1st Year	40,595,000	395,739.91(*1)	6,775,000	66,419.10
2nd Year	150,448,000	1,326,783.84(*2)	16,153,719	137,247.30
Total	191,043,000	1,722,523.75	22,928,719	203,666.40

*1: Calculated based on JPY by JICA official exchange rate of May 2014, 1USD=102.58JPY
*2: Calculated based on JPY by JICA official exchange rate of April 2016, 1USD=113.393JPY
*3: Amount of actual payment in USD.

2.4 Equipment

Equipments purchased by JICA Project Team are summarized in the following list. The equipments in the following list were used for the Project activities, and handed over to TTD after the project completion.

Table 2-6 Equipment List

	Item	Model	Qty	Unit Price
1	Digital Camera	Sony Cyber-shot WX100	1	USD 180.00
2	Digital Camera	Sony Cyber-shot WX100	3	USD 190.00
3	Digital Camera	Sony Cyber-shot DSC-WX200	1	USD 240.00
4	External HDD	Transcend Storejet 2.5 H3 1TB	6	USD 79.00
5	UPS	Intext 1500	1	USD 125.00
6	Laptop PC	Acer S7-391-i53314G12aws	2	USD1,555.00
7	Digital Video Camera	Canon Legria HF R36	1	USD 535.00
8	Copy Machine	Fuji Xerox DocuCenter IV C2263	1	USD 5,720.00
9	Printer	Brother Printer HL-4570CDW	1	USD 784.00
10	Desktop publishing software	InDesign CS6	3	JPY 88,800
11	Shredder	Comix	1	USD 69.00
12	Shredder	AURORA AS2030CD	1	USD380.00
13	Laser pointer	Logitech	1	USD50.00
14	Tripod	Canon	1	USD49.00

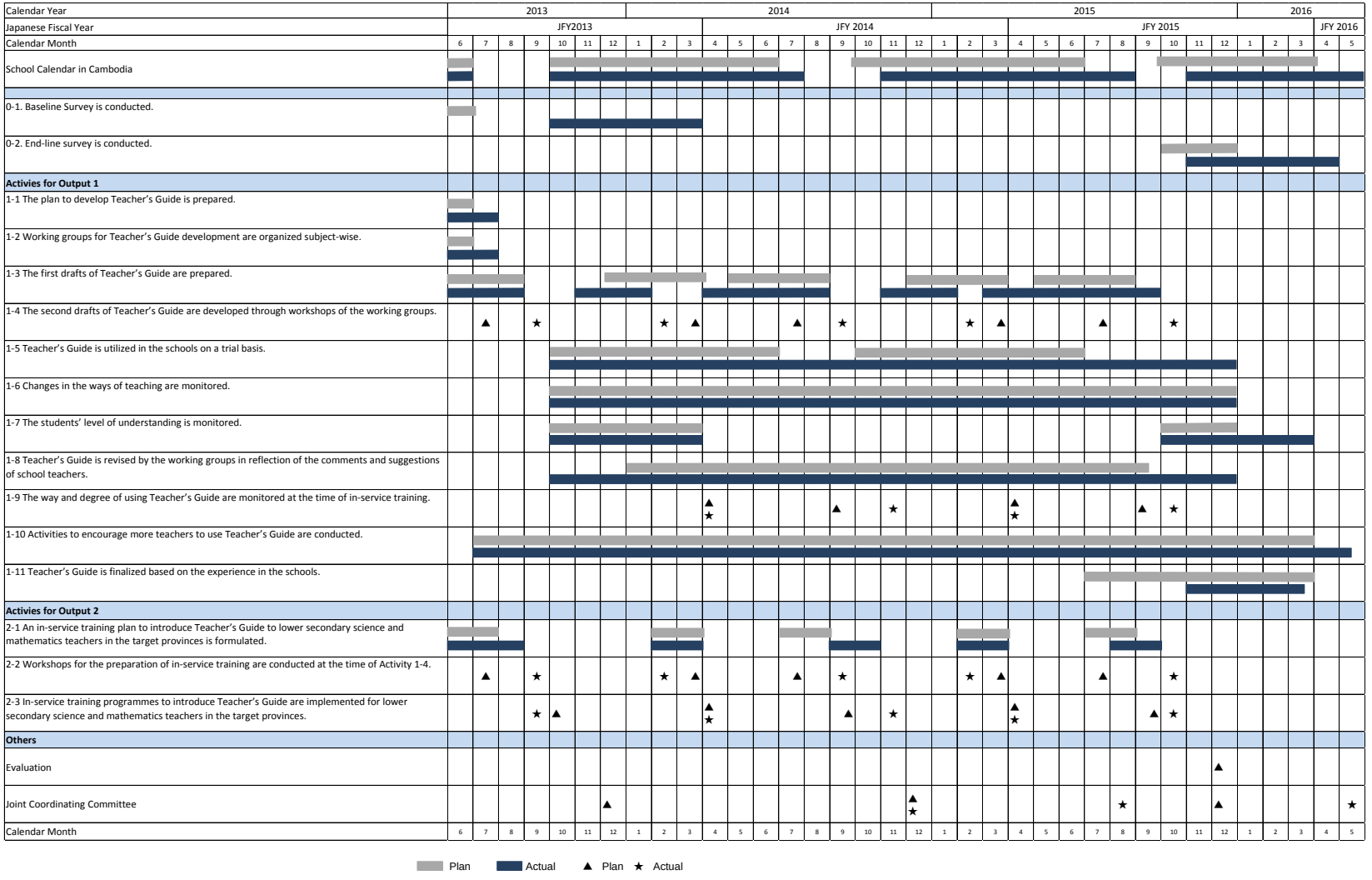
3. Project Activities

3.1 Summary of the Activities

During the Project period, the Project implemented the following activities. Plan of Operation, which indicates the project schedule, is as shown in the next page.

Teacher's Guide development	Developed a series of Teacher's Guide through five Activity Cycles. Teacher's Guide covers 123 lessons in total (21 lessons for Mathematics, 27 lessons for Physics, 22 lessons for Chemistry, 27 lessons for Biology and 26 lessons for Earth Science). The finalized Teacher's Guides were distributed to all the schools at the lower secondary level in the target provinces, all of six RTTCs, six POEs and MoEYS.
Working Group Seminar	Based on the draft Teacher's Guide, five WG seminars were held. WG members including RTTC trainers and POE staff participated to discuss on the Teacher's Guide and to prepare for the INSET.
Teacher's Guide introduction training (INSET)	Teacher's Guide Introduction Training was organized five times at six RTTCs. 5 participants (one for each subject) from each lower secondary school in the target provinces participated in the training program.
School director meeting	School director meetings were held four times in six target provinces. Either school director or vice-director of the lower secondary schools participated in the meetings.
Monitoring and Evaluation	As per the schedule below, a questionnaire survey for school directors, a questionnaire survey on mathematics and science teachers, and tests for the grade 8 and grade 9 students were conducted. Later, the results are used for cooperative analysis. November 2013 – March 2014: Baseline Survey January 2015 – July 2015: Impact Survey November 2015 – March 2016: End-line Survey
Monitoring Activities	POE school inspectors in coordination with the JICA Project Team carried out monitoring activities at the RTTC cooperative schools and the target schools mentioned above (Monitoring and Evaluation).
Monthly POE Meetings	24 POE meetings were held with participations of POE directors, inspectors and staff in charge of lower secondary level education in six target provinces.
Support towards "PISA for Development"	Team leader of the Project, Mr. Takahashi, together with the two representatives from Cambodia took part in the "PISA for Development" workshop held in Montreal, Canada in 09/29 to 10/03/2014. Subsequently, a workshop was held in Cambodia to share the lessons learned from the PISA workshop and to discuss its application to the future project operations in January 2015.
Support for policy development	The Project supported developing the Education Strategic Plan (ESP) 2014-2018, the Teacher Policy Action Plan (TPAP), and the Curriculum Revision Committee. Members of the JICA Project Team took part in the TPAP Task Force, and supported its implementation.
JCC meeting	JCC meeting was held three times during the project period; 8 December 2014, 11 August 2016, and 9 May 2016.
Sub-TWG	The Project participated in the Sub-Technical Working Group (Sub-TWG) meeting three times and reported the progress of the Project.

Table 3-1 Plan of Operation



3.2 Teacher's Guide Development

Teacher's Guide was developed based on a process of 1) the JICA experts developed the first draft of Teacher's Guide in English, 2) NIE trainers translated it into Khmer and localized it based on the Cambodian local context, 3) the draft Teacher's Guide was thoroughly reviewed by the central WG members, and 4) it was finalized after its review in the WG seminar including RTTC trainers. During the project period, the Project repeated this cycle of process five times, and eventually Teacher's Guide covering 123 lessons in textbook was prepared. It means that around 40% of all the lessons in the mathematics textbook were covered in the Teacher's Guide, and so did 70% of those in the science text book.

Table 3-2 Numbers of Lessons covered by the Teacher's Guide[4]

Subject	Grade 7	Grade 8	Grade 9
Mathematics	7/22	7/18	7/18
Physics	10/16	9/15	8/19
Chemistry	6/6	8/8	8/9
Biology	9/16	9/15	9/13
Earth science	9/11	8/13	9/12

Lessons to be covered by the Teacher's Guide were selected based on the following criteria;

1. Those lessons that were identified as "difficult" lessons by the teachers and students in the lower secondary schools in Phnom Penh and Kandal through the survey conducted by JICA Cambodia office,
2. Those lessons that were considered as essential lessons by the JICA experts (the JICA Project Team),
3. Those lessons that were in line with the schedule of Teacher's Guide development in terms of timing after reviewing the annual lesson plan of Phnom Penh, and
4. Those lessons included in the RTTC curriculum (In order for the Teacher's Guide to be relevant and useful for teacher training and to facilitate the current and future teachers to share the same knowledge).

In addition, for the Teacher's Guide vol. 3 onwards, lessons to be included were finally decided based on the result of the baseline survey. Please see the details of the lessons addressed in the Teacher's Guide in the Table 3-3.

[4] Number of lessons covered by the Teacher's Guide/ number of all the lessons in the textbook.

Table 3-3 Lessons covered by the Teacher's Guide

Subject	Gr		Volume 1		Volume 2		Volume 3		Volume 4		Volume 5
Math	**7**	**7**	Measurement	**20**	Probability	**18**	Volume and surface area of polygons	**16**	Perimeter and area of polygons	**14**	Parallel and perpendicular lines
								19	Reflection	**15**	Two dimensional geometric shapes
	8	**4**	Measurement	**11**	Probability	**10**	Statistics	**12**	Comparison of triangle	**3**	Aspect ratio and percentage
								18	Scale	**16**	Lines and special segments intersecting each other in a triangle
	9	**2**	Proportion	**8**	Probability	**10**	Linear equation	**7**		**13**	Circle and line
								18	Solid	**14**	Angles of circle
Physics	**7**	**1-2**	Thermal Expansion of a Body	**4-1**	Solid Pressure	**3-1**	Electric Charge	**4-3**	Hydraulic Pressure Measurement	**3-3**	Electrical Voltage
		1-3	Amount of Thermal Energy	**4-2**	Pressure Transfer of Fluid	**3-2**	Electric Current	**4-4**	Atmospheric Pressure	**3-4**	Electrical Resistance
	8	**1-2**	Instantaneous Velocity and Acceleration	**6-2**	Sound Receivers	**2-3**	Newton's Law	**5-1**	Magnet	**3-1**	Work, Energy
		1-3	Free-Fall	**6-3**	Reflections of Sound and Echo			**5-2**	Magnetic Fields	**3-2**	Power
	9	**2-4**	Pulley and Wheel and Axles	**5-1**	Straight propagation of light	**2-3**	Wheel and Gear	**5-3**	Refraction of light	**4-3**	Force of magnetic field on electricity
				5-2	Reflection of light			**5-4**	Lens	**4-4**	Electromagnet Inductions
Chemistry	**7**	**1-2**	Classification of Substances	**3-1**	The Air	**1-1**	Substance	**3-2**	Air Pollution	**2-2**	Factors of Phase Change of a Substance
						2-1	Phase Change of a Substance				
	8	**1-1**	Atom and Molecules	**3-1**	Water	**1-2**	Chemical Symbol, Formula and Chemical Reaction	**3-3**	Solution	**2-1**	Mixture
				3-2	Composition of Water	**1-3**	Elements, Pure Matters, and Compound			**2-2**	Mixture Separation
	9	**1-1**	The Periodic Table of Elements	**3-1**	Oxide	**1-2**	Element Properties in groups	**3-3**	Base	**2-1**	Carbon
				3-2	Acid			**3-4**	Salt	**2-2**	Oxygen
Biology	**7**	**2-2**	Plants With Flower	**4-2**	Components in the Digestive System	**3-1**	Structure of Cells	**5-1**	Medicine	**3-3**	Cells of Plants
		2-3	Transportation of Plants With Flower	**4-3**	Digestion	**3-2**	Structure of Human Organ	**5-2**	Tobacco and Cigarettes		
	8	**2-1**	Ecosystems in the Regions	**5-2**	Diet and Energy	**3-1**	Diffusion	**6-1**	Drugs	**4-3**	Cell Respiration
				2-2	Food Relationships in the Environment	**3-2**	Transport in Vascular Plants	**6-2**	The Effects of Drugs	**4-4**	Transport System
	9	**1-2**	Photosynthetic Process	**4-1**	Infectious Agents	**2-1**	Neuron	**3-1**	Body Defense	**2-3**	Peripheral Nervous System
				1-3	Plant Respiration	**2-2**	Central Nervous System	**4-2**	Infectious Disease	**3-2**	Immune System
Earth Science	**7**	**1-1**	Formation of the Solar System	**1-2**	The Special Star or the Sun	**1-3**	The Planets' Motions	**2-3**	The Seasons and Weather in Cambodia	**2-1**	Rotating Motion of the Earth
				2-2	The Seasons on the Earth	**1-4**	The Important Planets	**2-4**	Effect of Weather to Agriculture in Cambodia		
						1-5	Meteorite, Comet, Asteroid				
	8	**1-2**	The Earth's Atmosphere	**3-1**	Motion of the Earth and the Moon	**2-3**	The Rock Cycle	**3-3**	Lunar eclipses and solar eclipses	**1-1**	the Earth's Characteristics
				3-2	Phases of the Moon	**2-4**	Types of Rock	**3-4**	Tides		
	9	**2-1**	The Theory of Tectonics	**3-1**	Solid Waste	**2-2**	Faulting and Folding	**3-3**	Global Warming of Earth	**2-4**	Earthquake
				3-2	Air Pollution	**2-3**	Volcanoes	**3-4**	Shortage of Fresh Water in the Future	**2-5**	Mineral and Fossil Fuel

3.2.1 Utilization of the Teacher's Guide at Schools

The Project conducted a questionnaire survey during the 5th training program to identify the usability of the Teacher's Guide at schools. Following questions were asked to the participants.

1. After this training, I will use Teacher's Guide in my lessons (Use TG).
2. After this training, I will share Teacher's Guide with my colleagues (Share TG).
3. After this training, I will encourage my colleagues to use Teacher's Guide (Encourage Colleagues to use TG).

As a result, it was confirmed that most of the participants highly viewed the value of Teacher's Guide and they plan to share and utilize the Teacher's Guide at their schools.

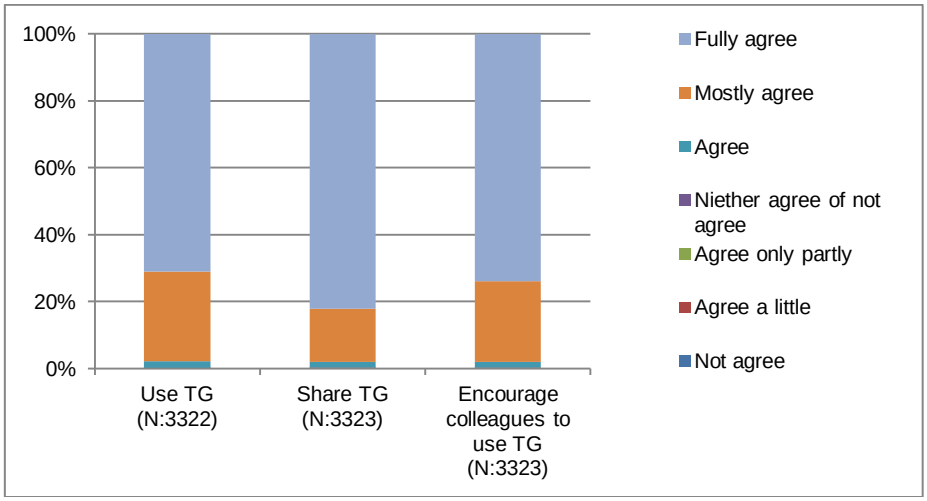


Figure 3-1 Utilization of the Teacher's Guide at Schools

Furthermore, the Project conducted an end line survey, in which the status of the Teacher's Guide reception and utilization among the target teachers was researched. Apparently, around 80% of the teachers received the Teacher's Guide and more than 70% of those who received the Teacher's Guide utilized it at their lessons. In the meantime, it was found out that there were some cases where the teachers did not even receive the Teacher's Guide and/or they did not utilize it according to the feedback sessions conducted during the training program, the monitoring of the training program by the WG members, and hearing sessions at the school director meetings and school monitoring. The reasons provided for the above mentioned situations are as follows.

<The reasons for not having received the Teacher's Guide >

- In case of the teacher who participated in the training program is not a Technical Group Leader (TGL), s/he may have some difficult times in distributing the Teacher's Guide to the other teachers in the same school. (In case of high schools, often times a high school teacher is appointed as a TGL and if s/he participates in the training program, in such case, what s/he has learned from the training program may not necessarily be disseminated to those teachers at the lower secondary level. Also, in some cases, if the teacher who participated in the training program is not TGL, it may be more challenging for s/he to be in charge for disseminating information from the training program to the other teachers.)
- In some cases, those teachers in charge of English, Khmer, History etc. participated in the training program and received the Teacher's Guide for mathematics and science. In these cases, it has been more difficult for the Teacher's Guide to reach to the teachers who

actually need it. (The Project reiterated the point many times that the training participants should be those who would actually use the Teacher's Guide in their daily lessons. However, more often than the Project would have hoped, the teachers in subjects other than math and science came to the training program due to limited understanding of the school directors on the objectives of the training program, especially before the Project started to hold the school director meetings.)

<The reasons for not utilizing the Teacher's Guide>

- The school budget is limited and the school does not have access to the tools and/or materials introduced in the Teacher's Guide. Therefore, some suggested experiments and activities in the Teacher's Guide are not easily implemented at school. (The Teacher's Guide provides some ideas to use the tools and materials that are commonly available so that the experiments and activities introduced in the Teacher's Guide can be easily conducted in the classroom; however, even the minimal level of supplies may not be available in some schools.)
- It takes much longer time to give lessons if the teacher uses the Teacher's Guide. (It is possible for the teacher to pick and choose what is needed to enrich his/her lessons based on the level of students and of their progress. However, not many teachers have ability to utilize the Teacher's Guide to his/her benefit.)
- Allocation of time for each lesson is determined and announced by MoEYS. The Teacher's Guide follows the time allocation set by MoEYS. However, some schools are not aware of such set time allocation and employ their own allocation of time. In this case, obviously the Teacher's Guide does not follow the time allocation of such school. Thus, the teachers may not be able to use the Teacher's Guide effectively. (In response to this problem, TTD reached out to those particular schools through POEs to rectify the situations.)
- Some teachers are so used to use only textbooks as teaching materials to give lessons, then, they are not accustomed to use other teaching materials. (This tendency is more obviously observed when the teachers are older.)
- In Grade 9, the teachers tend to pay more attention to the result of and preparation for the final exam, so that they don't have much time to include activities and experiments introduced by the Teacher's Guide into their lessons.
- Pictures used in the Teacher's Guide are difficult to see, and in some cases, the captions do not explain the details of the images very well and the terminology used there is not easy to understand.

The last point above has already been addressed by the central WG members and NIE trainers. They reviewed the entire Teacher's Guide and made some corrections based on the feedback received from teachers and schools. In addition, the final publication of the Teacher's Guide is in full color, which makes it easier for the readers to see the pictures clearly, while some of the subjects of the Teacher's Guide used in the training program were in black and white due to the budget constraints. As far as other points raised, constant efforts to improve the situations are required.

3.2.2 Relevancy of the Teacher's Guide

At the 5th training program, the Project conducted a questionnaire with regard to the relevancy of the Teacher's Guide. The results are as follows. Most of the respondents stated that the level of explanation in the Teacher's Guide was relevant, regardless of subjects, thus we can conclude that the content of the Teacher's Guide was just at the right level for the target group.

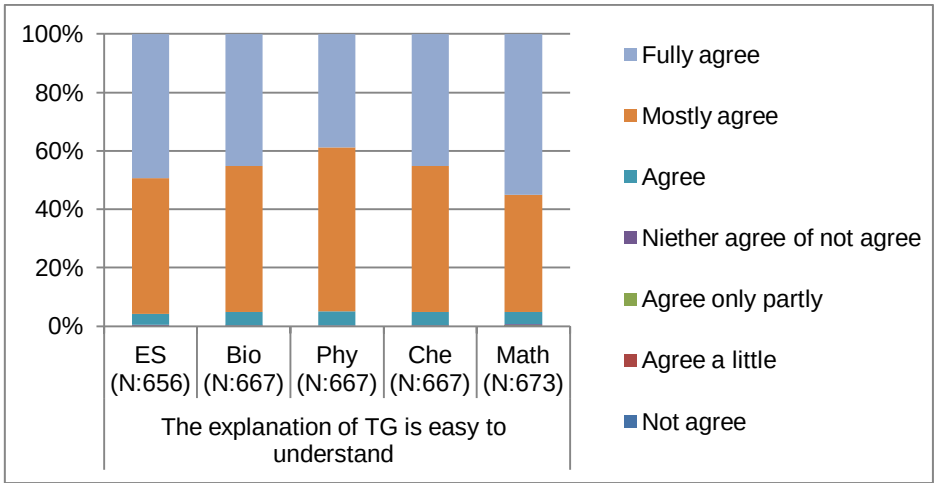


Figure 3-2 The Level of Explanation in the Teacher's Guide

Out of all the points introduced in the Teacher's Guide, for those additional exercises and small tests that the students use, the Teacher's Guide provided just adequate level of exercises according to the respondents (Figure 3-3). When the Project conducted monitoring, it was confirmed that the exercises and small tests introduced in the Teacher's Guide were effectively used (sometimes, the same exercises were used with figure changes). Therefore, it is expected that the Teacher's Guide would continue to be relevant and used in the daily lessons.

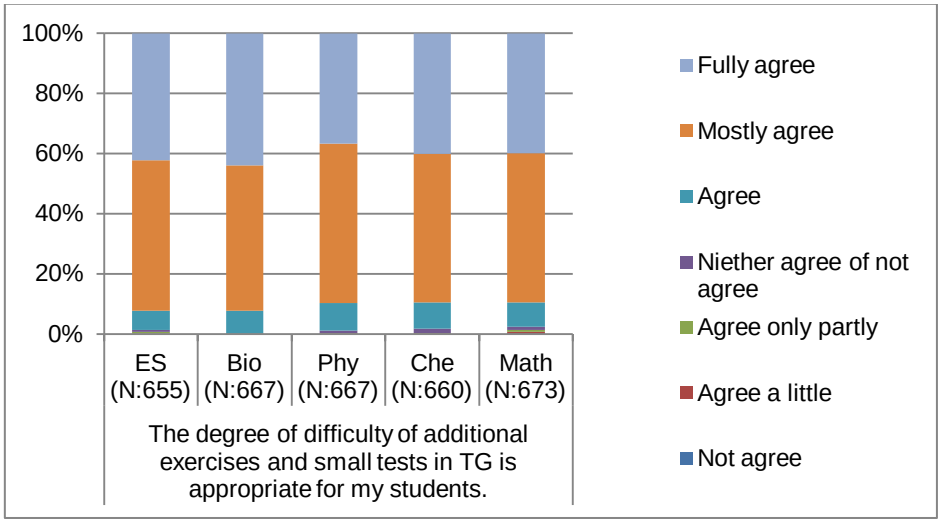


Figure 3-3 The Degree of Difficulty of Additional Exercise and Small test in TG

In addition, in all subjects, the Teacher's Guide was valued highly with regard to improvements in the level of students' achievement (Figure 3-4). Therefore, it is concluded that teachers are recognizing the effectiveness of the Teacher's Guide for the improvement of students' achievement.

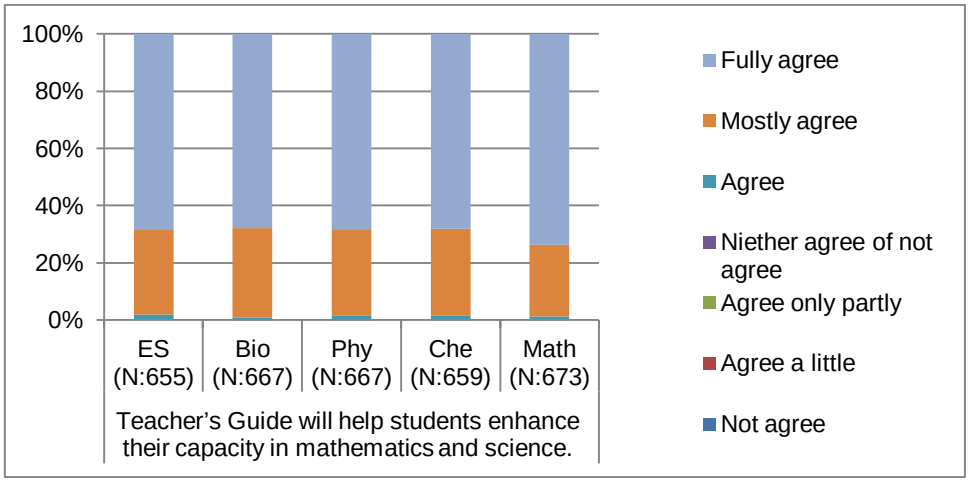


Figure 3-4 Impact of Teacher's Guide on Students

The respondents mostly agreed that the activities introduced in the Teacher's Guide are implementable at school. The overall rating was very high, while chemistry and physics were slightly lower. It is probably because schools do not have the necessary tools and materials for some activities and experiments introduced by the Teacher's Guide for those subjects. Nonetheless, the Project considered the current situation of the school and tried to introduce simple activities and experiments which can be easily conducted with materials available around, such as PET bottles. We believe that those ideas contributed to the high overall rating of the Teacher's Guide.

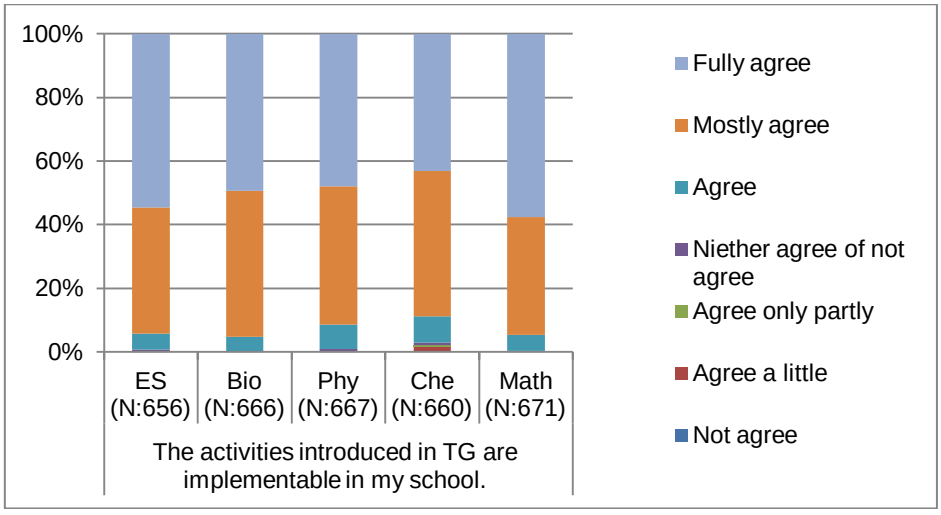


Figure 3-5 Applicability of the Teacher's Guide at School

Not a single respondent stated a negative comment with regards to the impact of the Teacher's Guide to their daily lessons, thus the Teacher's Guide was highly valued by the teachers in general. Based on this, it is concluded that the level of teachers' satisfaction and evaluation on the Teacher's Guide is high, as well as its relevancy is highly acknowledged.

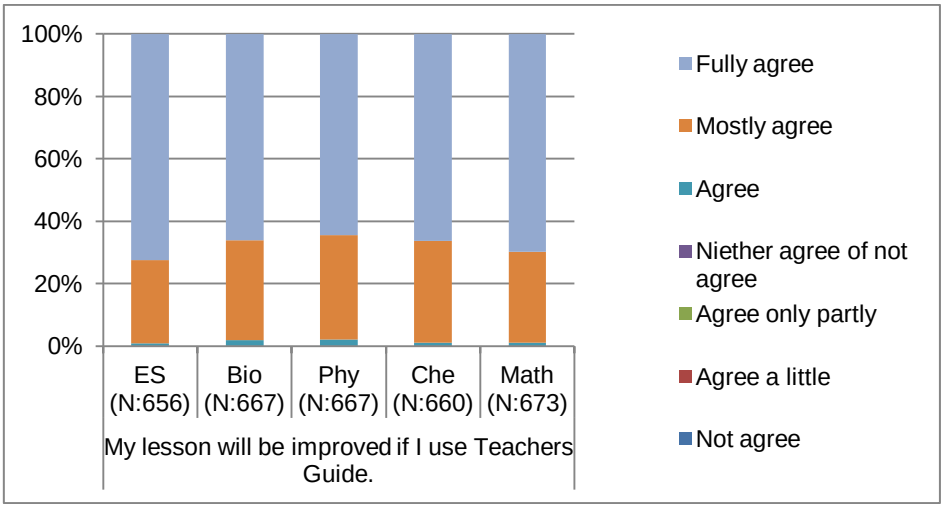


Figure 3-6 Impact of the Teacher's Guide on Lessons

Regarding the change of students' response after teachers started using the Teacher's Guide was asked at the end line survey. Following are their answers;

- Students understand quickly and deeply. They gained more knowledge on subject.
- Students got more interested in the subject; especially the pictures and images related to the experiments attract them.
- Students have become more eager to learn (those absent the classes decreased.)
- Students enjoy learning and more involve in the lessons.
- Many more students involve in lessons and raised more questions.
- Many more students "think" more.
- Students became more confident in responding any questions as they know the answers based on their experiences gained from activities introduced by the Teacher's Guide.
- When asked, students tend to respond with correct answers more frequently.
- Students remember well about the lessons which some experiments were conducted.
- Students tend to have more of their original ideas and opinions.
- Learning about different teaching methods, the teachers feel that their lessons have evolved. Accordingly, they feel that their students and their attitude towards learning have changed.
- Students understand more about the experiment and observation.
- Students' achievement was improved thanks to their active participation in the lessons, and those who conducted some experiments in the lessons could easily answer the questions asked.
- More students can answer difficult questions.
- More accurate and credible answers are provided by the students who participated in the lessons.
- Students are more interested in learning from experiments than learning the theory in the textbook. Thus, they have become more actively involved in the experiments.
- Students have overcome the uneasy feelings towards Chemistry and they now think that Chemistry is not hard to deal with. (An answer from a chemistry teacher)
- Students started to enjoy learning mathematics. (An answer from a mathematics teacher)
- It seems like that the students have truly understood the content of the lessons, so they can most probably apply the concept into their daily lives.
- Students tend to do more exercises as they understand the contents of the lessons better.
- The Teacher's Guide helped the teachers give lessons more comfortably, which contributed to improvements in students' achievement.
- Students tend to provide more assistance to the teachers, especially during the experiments.

- Students can find answers to the questions by themselves through conducting relevant experiments.
- Students now can learn from each other and they have created a "Student club".
- Not only the students, but also the teachers have now better understanding of the lessons after conducting the experiments introduced in the Teacher's Guide.
- Teachers can boost their level of confidence by observing the positive changes in their students.
- Teachers feel that their students are now enjoying their lessons more.
- During the class, students have more actively involved in discussions and been making responsible remarks.
- Before using the Teacher's Guide, students tend to answer questions based on their memorialized knowledge; however, after using the Teacher's Guide, the students tend to answer questions based on their own experiences gained through experiments conducted in the class.
- For those lessons where students demonstrated some difficulties in learning, the Teacher's Guide was very instrumental. With the help of the Teacher's Guide, the students can understand the lessons more deeply.
- Based on the better level of understanding of the lessons, students started to raise more questions which beyond the contents of the textbook.
- Students are more focused and attentive during the class.
- Students are more focused during the class, and accordingly, we have fewer dropouts.
- Students learn not only from memorization of the lessons, but also from doing more learning exercises. Thus, they are now more interested in learning from doing some exercises.
- More students do more homework.
- Students tend to have more diverse opinions and questions when the Teacher's Guide is used in the class.
- Students become more active in responding to questions that the teachers asked.
- Students understand the content of the textbook well enough to point out some mistakes by themselves.

Thus, some positive changes are observed in students and in their ability to learn when the Teacher's Guide is effectively used in the lessons. It seems that the Teacher's Guide is very effective in improving quality of lessons. If the teachers continue to use the Teacher's Guide and apply its teaching methods, there will be a high possibility that the students will be benefited from such quality education, then, their achievement would be improved. Having said that, some teachers pointed out that the students who have good fundamentals could learn better and improved their achievements, but those students who do not even have basic knowledge of certain subject would not really be benefitted from the lessons offered with the Teacher's Guide. This point is reiterated by the Project's monitoring. Some teachers pointed that it was difficult for him/her to teach the students who don't have foundation to learn from primary education level. Therefore, it is imperative for MoEYS to address the educational needs from the primary education level at the same time.

3.2.3 Utilization of the Teacher's Guide at Teacher Training

After the 5th INSET, the Project asked the RTTC trainers about the utilization status of the Teacher's Guide at their teacher training program at RTTCs. 66 out of 71 RTTC trainers responded saying that they have used the Teacher's Guide in their teaching at RTTC[5]. In addition, 67 respondents confirmed that they suggested RTTC trainees to use the Teacher's

[5] Reasons why they didn't use the Teacher's Guide included that; limited time to use (1 trainer), now not teaching at RTTC but working at POE (1 trainer), no answer (3 trainers).

Guide for their practice teaching[6]. Furthermore, 62 respondents confirmed their usage of the Teacher's Guide in the up-grading training program, which is a training program that is offered for the primary school teachers to be able to teach at the lower secondary schools (RTTC trainers are the ones who teach at such training program)[7]. These results confirm that the Teacher's Guide is widely accepted as an effective instrument in the teacher training program, and the RTTC trainers are the driving force for the usage of the Teacher's Guide.

At the JCC meeting on 11 August 2015, H.E Nath Bunroeun instructed TTD to use the Teacher's Guide at the up-grading training program. It was also decided that the Teacher's Guide would be used for the teacher training at RTTCs, at the consultation meeting on 12 January 2016. Subsequently, TTD, DCD, and GSED jointly drafted a guideline on the utilization of the Teacher's Guide and it was published in the Guide. It would be even more effective if RTTC trainers instruct their trainees to use the Teacher's Guide for their practice teaching. Based on the above positive developments, it is expected that the utilization of the Teacher's Guide would be institutionalized in the teacher training program.

3.2.4 Utilization of the Teacher's Guide in Other Program

As of now when this report is being prepared, Asian Development Bank (ADB) is planning to use the Teacher's Guide in its Third Education Sector Development Project (ESDP3) as one of training materials for INSET. ESDP3 also plans to develop a website with all the educational resources available for science and mathematics prepared by several development partners such as Vlaamse Verenigin voor Ontwikkelingshulp en Technische Overseas (Flemish Association for Development Cooperation and Technical Assistance - VVOB) and Voluntary Service Overseas (VSO). Through the website, any educational resource and material can be downloaded when and if needed. The Teacher's Guide developed by the Project will also be included in the list of educational resources available at the website. In anticipation of being utilized in ESDP3, the Teacher's Guide includes key learning points extracted from BETT[8] and SEAL[9] materials. Therefore, it is very user-friendly and it does not require looking up different educational materials from different sources.

3.2.5 Publishing and Distribution of the Teacher's Guide

Originally, it was planned to publish one guide for mathematics per grade, and one guide for all the subjects under science (Physics, Chemistry, Biology and Earth Science) per grade, according to the structure of the current textbook. However, after much discussions with TTD, GSED, DCD, Department of Finance, and ESDP3, it was decided that the Teacher's Guide for science would be divided into four subjects per grade, considering the best interest of the teachers who use the Teacher's Guide at school and their usability, and flexibility in revising and editing in future.

The copies of the Teacher's Guide were distributed according to Table 3-4. The copies of the Teacher's Guide were distributed to each school based not on the number of teachers in science and mathematics, but on the number of teachers who are in charge of actually teaching the concerned subject[10]. The information regarding the current situation of the teachers who actually teach the target subjects was reported by the school directors by the 3rd school director

[6] Reasons why they didn't suggest to use the Teacher's Guide included that; not instructed to do so (1 trainer), now not teaching at RTTC but working at POE (1 trainer), no answer (2 trainers).
[7] Reasons why they didn't use the Teacher's Guide included that; it doesn't match with the training curriculum (2 trainers), limited time to do so (3 trainers), not instructed to do so (1 trainer), now not teaching at RTTC but working at POE (1 trainer), no answer (2 trainers).
[8] Basic Education and Teacher Training implemented by Belgian Technical Cooperation.
[9] Science, Environment, Agriculture, Life skills implemented by VVOB.
[10] So if a teacher is teaching three subjects, he/she is counted three times.

meeting. Based on that number, the copies of the Teacher's Guide were distributed to all of the lower secondary schools in target provinces. Once the copies were received by the school, the school would keep and manage the copies. Each concerned teacher would be loaned a copy of the Teacher's Guide to use it in his/her class.

The case of distribution of the Teacher's Guide to RTTCs is different. In order for each trainee to use it throughout his/her class and s/he can utilize it in the practice teaching, the copies of the Teacher's Guide were distributed according to the number of trainees of the target subject.

In MoEYS, TTD received numbers of copies of the Teacher's Guide considering the needs identified by ESDP3. In addition, for those provinces outside the Project scope, it was decided that MoEYS would put their own resources to finance publication and distribution of the Teacher's Guide, and 22,649 copies all together are planned to be distributed. It was already approved by the H.E Minister of MoEYS and the Ministry of Economic and Finance. The copies would be printed with the budget for 2016 and they will be distributed in 2017.

Table 3-4 Number of Copies of the Teacher's Guide Distributed by the Project

Math & Science Teachers (To schools)

No.	Province	Grade 7					Grade 8					Grade 9				
		Math	Physics	Chem	Biology	ES	Math	Physics	Chem	Biology	ES	Math	Physics	Chem	Biology	ES
1	Phnom Penh	208	424	424	424	424	190	418	418	418	418	182	445	445	445	445
2	Kandal	219	533	533	533	533	194	527	527	527	527	179	519	519	519	519
3	Takeo	289	526	526	526	526	284	517	517	517	517	271	523	523	523	523
4	Prey Veng	258	455	455	455	455	233	451	451	451	451	212	442	442	442	442
5	Kampong Cham	214	413	413	413	413	195	411	411	411	411	182	411	411	411	411
6	Battambang	252	391	391	391	391	229	386	386	386	386	223	370	370	370	370
Total		1,440	2,742	2,742	2,742	2,742	1,325	2,710	2,710	2,710	2,710	1,249	2,710	2,710	2,710	2,710

RTTC

No.	Province	Grade 7					Grade 8					Grade 9				
		Math	Physics	Chem	Biology	ES	Math	Physics	Chem	Biology	ES	Math	Physics	Chem	Biology	ES
1	Phnom Penh	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
2	Kandal	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
3	Takeo	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
4	Prey Veng	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
5	Kampong Cham	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
6	Battambang	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Total		350	350	350	350	350	350	350	350	350	350	350	350	350	350	350

MoEYS (TTD)

MoEYS	Grade 7					Grade 8					Grade 9				
	Math	Physics	Chem	Biology	ES	Math	Physics	Chem	Biology	ES	Math	Physics	Chem	Biology	ES
	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450
Total	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450

POE

No.	Province	Grade 7					Grade 8					Grade 9				
		Math	Physics	Chem	Biology	ES	Math	Physics	Chem	Biology	ES	Math	Physics	Chem	Biology	ES
1	Phnom Penh	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
2	Kandal	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
3	Takeo	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
4	Prey Veng	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
5	Kampong Cham	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
6	Battambang	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Total		30	30	30	30	30	30	30	30	30	30	30	30	30	30	30

WG members

WG	Grade 7					Grade 8					Grade 9				
	Math	Physics	Chem	Biology	ES	Math	Physics	Chem	Biology	ES	Math	Physics	Chem	Biology	ES
	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Total	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30

Extra copies (If remained, give to MoEYS)

MoEYS	Grade 7					Grade 8					Grade 9				
	Math	Physics	Chem	Biology	ES	Math	Physics	Chem	Biology	ES	Math	Physics	Chem	Biology	ES
	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Total	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20

Total	Grade 7					Grade 8					Grade 9				
	Math	Physics	Chem	Biology	ES	Math	Physics	Chem	Biology	ES	Math	Physics	Chem	Biology	ES
	2,320	3,622	3,622	3,622	3,622	2,205	3,590	3,590	3,590	3,590	2,129	3,590	3,590	3,590	3,590

3.3 Working Group Seminar

The Project held five Working Group Seminar (WG seminar) right before each training program, in order to review the draft of Teacher's Guide and to prepare for the training program. While the first WG seminar was conducted for three days, the 2nd WG seminar and after required four days in order to have enough time for preparation and discussion for each subject. In addition to approximately 90 participants from the WG members (MoEYS and its relevant departments and all the RTTC trainers in science and mathematics), NIE trainers and POE staff from the target provinces took part in the seminar. TTD facilitated the common session, and the NIE trainers who drafted the Teacher's Guide acted as resource persons and conducted the subject-wise sessions where each subject in the Teacher's Guide was reviewed and discussed. A sample program of the seminar is shown below.

At the beginning, the NIE trainers explained the content of the Teacher's Guide and the RTTC trainers prepared instrument and materials required for the up-coming training program. However, from the 4th WG meeting onward, RTTC trainer was given a responsibility to conduct a mock lesson using the Teacher's Guide from its preparation to its actual implementation. By doing so, the RTTC trainers can be more committed to their assignments, the level of training program can be maintained at a desirable level regardless of the ability of RTTC trainer in charge, and the trainers can learn from each other. The training program structure was designed to allow the trainers to receive feedbacks from the NIE trainers and other RTTC trainers, so that the quality of the training program can be improved. In addition, based on the training package (training manuals and hand-outs) prepared by the Project, the flow and key points of the training program were reviewed and confirmed at the seminar.

Table 3-5 A Sample Program of the WG Seminar

HH	MM	Day 1	Day 2
8:	00	**Registration**	***Subject-wise***
	15	***Common***	[**Practice**] (135 min)
	30	Opening: TTD Director	・ Teaching practice on Grade 7 TGs
	45	・ Report of 4th INSET	➔ Performed by 2 RTTC trainers
9:	00	***Common***	
	15	・ Next INSET	
	30	Time table & manual for Implementation	
	45	**Break**	
10:	00	***Subject-wise***	
	15	・ Testing the current understanding on the contents of TG Vol.5	**Break**
	30	- Test (30 min)	
	45	- Questionnaire (10 min)	**[Tasks]**
11:	00	- Marking, review and discussion (50 min)	・ Discuss the lesson for further improvement.
	15	(Use the same test and questionnaire with those for teachers in INSET)	・ Finalize the "check-list" for INSET.
			・ Finalize the time allocation sheet for INSET.
11:	**30**	**Lunch**	
14:	00	***Subject-wise***	***Subject-wise***
	15	[**Contents**]	[**Contents**]
	30	・ Discuss the contents of TG for Grade 7	・ Discuss the contents of TG for Grade 8
15	30	**Break**	**Break**
	45	・ Continue the task	・ Continue the task
		At the end of the session,	At the end of the session,

16:	00	- Read carefully through the "check-list" in the whole class. - Select 2 RTTC trainers for teaching practice on Day 2. (They also prepare a draft "Time allocation sheet" for Grade 7 TG.)	- Read carefully through the "check-list" in the whole class. - Select 2 RTTC trainers for teaching practice on Day 3. (They also prepare a draft "Time allocation sheet".)
	15		
	30		
	45		
17:	**00**	**End of the Day**	

HH	MM	**Day 3**	**Day 4**
8:	00	***Subject-wise***	***Subject-wise***
	15	[**Practice**] (135 min) ・ Teaching practice on Grade 8 TGs ➔ Performed by 2 RTTC trainers	[**Practice**] (135 min) ・ Teaching practice on Grade 9 TGs ➔ Performed by 2 RTTC trainers
	30		
10	15	**Break**	
	30	**[Tasks]** ・ Discuss the lesson for further improvement. ・ Finalize the "check-list" for INSET. ・ Finalize the time allocation sheet for INSET.	**[Tasks]** ・ Discuss the lesson for further improvement. ・ Finalize the "check-list" for INSET. ・ Finalize the time allocation sheet for INSET.
	45		
11:	00		
11:	**30**	**Lunch**	
14:	00	***Subject-wise*** [**Contents**] ・ Discuss the contents of TG for Grade 9	***Subject-wise*** ・ Review the test and questionnaire on Day 1. ・ List up necessary materials for INSET
	15		
	30		
15	15		**Break**
	30	**Break**	***Common*** • Role-share for the next INSET • Issues to share with TTD and project team Closing: TTD Director
	45	・ Continue the task At the end of the session, - Read carefully through the "check-list" in the whole class. - Select 2 RTTC trainers for teaching practice on Day 4. (They also prepare a draft "Time allocation sheet".)	
16:	00		
	15		
	30		
	45		
17:	**00**	**End of the Day**	

3.4 Teacher's Guide Introduction Training (INSET)

3.4.1 Overview of the Training Program

5 training programs to introduce the Teacher's Guide to the target schools and teachers were organized as per schedule shown in the table below. Each training program lasted for two days and participants were divided into several batches (each batch should be around 30 participants) depending on the target number of teachers in each province. Total of five participants; one representative for each subject from all the lower secondary schools in the target provinces were invited to participate in the training program. While a POE staff in charge of the training program (a staff in charge of secondary education and school inspector) took a lead on the overall management and acted as a moderator of the common training session, RTTC trainers were in charge of subject-wise sessions. Central WG members from MoEYS, NIE trainers and

the JICA Project Team took the supporting role in implementation of the training program through monitoring its status at different locations. Furthermore, a local company, Forval Cambodia Co., Ltd was sub-contracted to provide administrative supports for the implementation of the training programs (such as distribution of training materials, procurement of necessary training materials, management of the list of attendance, payment of allowance and accommodation fee to the participants, etc.).

Table 3-6 Summary of the Training Program

No.	Date	Volume of The TG	Targets
1	September 29 to October 31, 2013	Vol. 1	750 schools／3,750 teachers
2	March 28 to April 10, 2014	Vol. 2	750 schools／3,750 teachers
3	November 27 to December 16, 2014	Vol. 3	676 schools／3,380 teachers
4	March 30 to April 11, 2015	Vol. 4	676 schools／3,380 teachers
5	October 23 to October 31, 2015	Vol. 5	677 schools／3,385 teachers

In this training program, the participants had opportunities to learn and discuss the concepts introduced by the Teacher's Guide, the methods by which they can utilize the Teacher's Guide effectively into their daily lessons, and the ways in which they can share what they had learned from this training program with other teachers in the same school. A sample training program agenda is as shown in the table below. On the first day of the training program, the participants reviewed the Teacher's Guide that was distributed in the previous training and discussed how to improve the usability of the Teacher's Guide and pointed out the areas of improvements (Session 2). After that, a pre-training test was conducted to check how well the participants had understood the content of the concerned lessons prior to this training program by themselves, and identify the areas that require more attention to learn, which contributed to make the participants keep their motivation high and focused on particular areas in the training program. For the sessions for the Teacher's Guide (Session 4, 5, 6), the Project introduced a checklist of the items that need to be included in each session and attempted to minimize the discrepancies among the sessions conducted by different RTTC trainers. The checklist was used not only by the RTTC trainers themselves, but also by the MoEYS staff (WG members) who conducted monitoring operations, POE staff in charge of the training program, and even some participants. In addition, after the sessions to introduce the Teacher's Guide on the 2nd day, the participants had a session where they had a chance to review their pre-training test results (on the 1st day) and checked if their understanding of certain areas where they had poor understanding previously was improved or not (Session 7). Furthermore, the Project made an extra effort to minimize any confusion that may have aroused among different training materials, by adding clear instruction (how to use the training materials) for the RTTC trainers at the header of each training material, as the training program required using many different types of training materials.

Table 3-7 A Sample Training Program (example of the 4th training)

HH MM	Day 1	Day 2
8:00 15 30 45 **9:**00 15 30 45 **10:**00 15 30 45	**1. Opening** Common session (POE) @Hall • *Move to each classroom* **2. Feedback on the use of TG Vol.3** *Subject-wise Session (RTTC trainer) @Subject classrooms* **Break** **3. Checking the understanding of the contents of TG Vol.4** *Subject-wise Session (RTTC trainer) @Subject classrooms* **4. Introduction to Grade 7 TG Vol.4** *Subject-wise Session (RTTC trainer) @Subject classrooms*	**(Continue)** *Subject-wise Session (RTTC trainer) @Subject classrooms* **6. Introduction to Grade 9 TG Vol. 4** *Subject-wise Session (RTTC trainer) @Subject classrooms* **Break** **(Continue)** *Subject-wise Session (RTTC trainer) @Subject classrooms*
11:00 –14:00	**Lunch Break**	**Lunch Break**
14:00 15 30 45 **15:**00 15 30 45 **16:**00 15 30 45	**(Continue)** *Subject-wise Session (RTTC trainer) @Subject classrooms* **Break** **5. Introduction to Grade 8 TG Vol. 4** *Subject-wise Session (RTTC trainer) @Subject classrooms*	**7. Reviewing the programme** *Subject-wise Session (RTTC trainer) @Subject classrooms* • Look back the test questions Day 1 and see the progress of oneself) • Make requests for next Teacher's Guide Vol. 5 • Evaluate the training programme and one's progress **8. Discussion on TG dissemination at schools** *Divided by School (POE & RTTC trainer) @Subject classrooms* **Break** **9. Wrap-up / Closing (POE)** *Common session (POE) @Hall*
17:00	**End of the Day**	**End of the Training**

3.4.2 Results of the Training Participation

As shown in the table below, the rate of participation in the training program is noticeably high, and it is still on the rise along with the development of the training program. At the 5th training program, at least one participant was sent out from all of the target schools, and the teachers' participation rate reached the level of 98.8% (Table 3-10). Altogether, a series of five training programs involved the total number of 17,216 participants (Table 3-9).

Table 3-8 Participation Rate of the Schools[11]

Province	1st	2nd	3rd	4th	5th
Phnom Penh	65/66 (98.5%)	66/66 (100%)	65/66 (98.5%)	66/66 (100%)	66/66 (100%)
Takeo	118/118 (100%)	117/117 (100%)	117/117 (100%)	117/117 (100%)	118/118 (100%)
Prey Veng	119/121 (98.3%)	121/121 (100%)	121/121 (100%)	121/121 (100%)	121/121 (100%)
Battambang	117/121 (96.7%)	115/115 (100%)	115/115 (100%)	116/116 (100%)	116/116 (100%)
Kandal	127/127 (100%)	135/135 (100%)	137/137 (100%)	136/136 (100%)	136/136 (100%)
Kampong Cham	196/197 (99.5%)	195/196 (99.5%)	120/120 (100%)	117/120 (97.5%)	120/120 (100%)
All	742/750 (98.9%)	749/750 (99.9%)	675/676 (99.9%)	673/676 (99.6%)	677/677 (100%)

Table 3-9 Participation Rate of the Teachers[12]

Province	1st	2nd	3rd	4th	5th
Phnom Penh	93.9%	95.8%	94.2%	94.8%	94.8%
Takeo	98.6%	98.1%	98.6%	98.2%	100%
Prey Veng	94.5%	96.2%	97.0%	97.2%	98.3%
Battambang	96.0%	99.1%	99.1%	99.5%	100%
Kandal	98.9%	96.0%	97.2%	97.5%	98.1%
Kampong Cham	97.0%	98.0%	98.5%	96.3%	99.7%
All	96.7%	97.3%	97.7%	97.4%	98.8%
Phnom Penh	3,628	3,650	3,302	3,293	3,343

[11] Number of participating schools divided by the number of total schools in the target provinces. It was calculated based on the attendance sheet. Even if the participant was alone from a school, the school was counted as a participating school.

[12] Number of participants divided by the target school x 5 teachers. It was calculated based on the attendance sheet. In some cases, the participating school is relatively small in size, thus five teacher participants per school were simply not an option. The figure does not reflect such cases and calculated based on the net participation target.

Table 3-10 Participation Rate of the Teachers (Net)[13]

Province	1st	2nd	3rd	4th	5th
Phnom Penh	N/A	95.1%	94.2%	97.8%*	97.5%*
Takeo	N/A	98.1%	98.6%	98.2%	100%
Prey Veng	N/A	97.2%*	98.0%*	98.3%*	99.5%*
Battambang	N/A	99.1%	99.5%*	99.7%*	100%
Kandal	N/A	97.3%*	98.1%*	99.3%*	99.1%*
Kampong Cham	N/A	97.9%	98.5%	96.3%	99.7%
All	N/A	97.7%*	98.1%*	98.3%*	98.8%*

This very high participation rate is most probably attributed to the fact that POE, which was in charge of the management of the training program, proactively and individually approached to each one of the target schools to encourage its participation (POE even contacted all the schools that failed to attend the morning session of the first day of training, and urged them to come to join the rest of the training program.). Also, POE secured the commitment from school directors to this training program through the school director meetings prior to each training program after the 4th one, which contributed to the success of the training program.

According to the questionnaire conducted to the participants after the 2nd training program, it was confirmed that the majority of participants were well aware of the purpose of the training program, which suggested that POE successfully assumed its role as an organizer of the training program. In addition, the result also suggested that the participants gradually confirmed the relevancy of the training program as well as the high usability of the Teacher's Guide as the training program moved forward. It was assumed that more and more active and heated discussions took place at the training program, which contributed to the high participation rate.

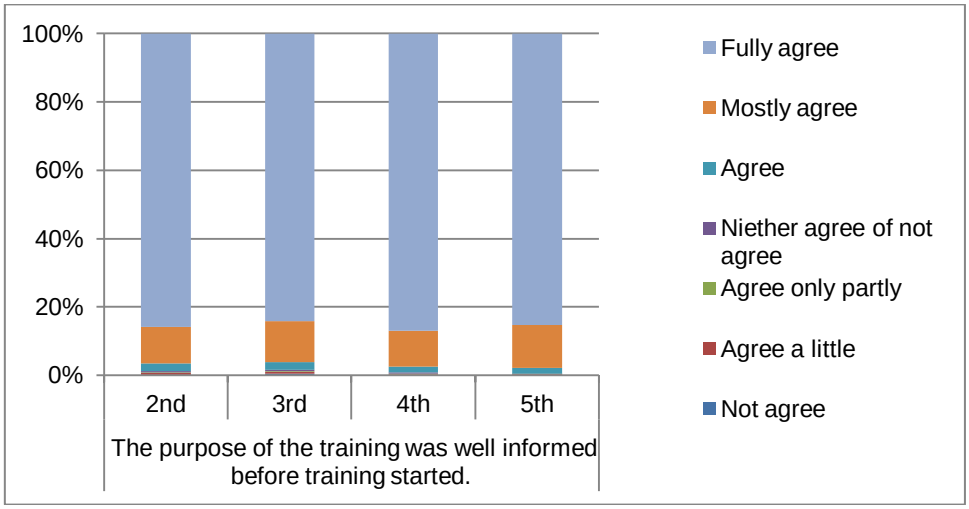


Figure 3-7 Level of Understanding by Participants on Training Purpose

[13] Number of participating teachers divided by the number of nominated teachers. It was calculated based on the attendance sheet. In some cases, the participating school is relatively small in size, thus five teacher participants per school were simply not an option. In this case, the rate is calculated based on the number of participants who were nominated for the training program (no data available for the 1st training program.)

The following table shows the detailed attendance rate in each of 4 sessions during the course of two-day training program; 1) the 1st day morning session, 2) the 1st day afternoon session, 3) the 2nd day morning session, 4) the 2nd day afternoon session. Except in Phnom Penh, the rate remained at the range of high 90%, which was commendably high rate. Phnom Penh, on the other hand, scored a lower attendance rate compared to that of other regions. Although POE Phnom Penh approached all the schools that were missing the 1st day morning session and urged their participation to the training program immediately, the rate remained relatively low, and POE struggled to improve this rate. According to the analysis by POE Phnom Penh, the reasons why the attendance rate in Phnom Penh struggled were due to the fact that incentives for the participants were lower as they received only the minimum allowance based on their proximity to the training venue, and they had plenty of opportunities to earn extra money by tutoring and other second jobs, thus chose to work instead of participating in the training program. This point needs to be revisited for future interventions.

Table 3-11 Attendance Rate of the Participants[14]

Province	1st	2nd	3rd	4th	5th
Phnom Penh	84.9%	90.4%	88.2%	88.2%	92.9%
Takeo	99.4%	99.7%	98.4%	96.7%	99.0%
Prey Veng	99.8%	99.7%	99.5%	99.5%	99.7%
Battambang	99.6%	98.3%	98.4%	99.0%	99.5%
Kandal	99.6%	99.1%	97.1%	97.9%	99.4%
Kampong Cham	99.6%	99.4%	99.8%	100%	99.8%
All	98.3%	98.5%	97.6%	97.6%	98.9%

Regarding the length of the training program, more than 80 % of respondents responded that 2-day-program was just the right length as the result of questionnaire shows below. In the meanwhile, some participants thought it was too short. According to the RTTC trainers who led the training sessions, and the WG members from MoEYS who monitored the progress of the training program, it was very challenging to manage time because the participants spent much more time in understanding the basics of the Teacher's Guide, than in discussing how to use it effectively in their lessons. This is due to the fact that the participants' level of knowledge in subjects covered in the Teacher's Guide was much lower than expected. Therefore, some participants felt like needing more time for the training program.

[14] Total of the sessions attended by participants divided by the number of participants multiplied by 4 Sessions, based on the list of attendance.

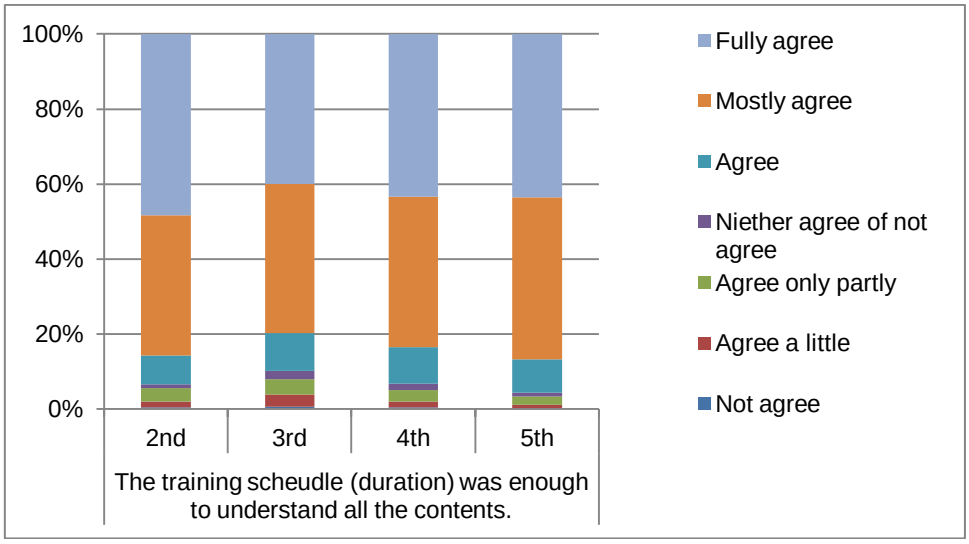


Figure 3-8 Validity of the Training Duration

3.4.3 Benefit from the Training Program

The participants seemed to have satisfied with the training program and benefitted from it. Some comments provided as follows; "I was not sure about the mistakes in the textbook, but the training program helped me understand and solve my questions. Now, I feel confident." "It was a great opportunity for me to discuss the content of the Teacher's Guide with the RTTC trainers and other teachers, which really helped me to enrich my overall subject knowledge." According to the questionnaire conducted after the 5th training program, all the participants agreed to the statement, "The training program helped me clear up the problems that I faced in teaching." (60% fully agreed, 37% mostly agreed, and 3% agreed.).

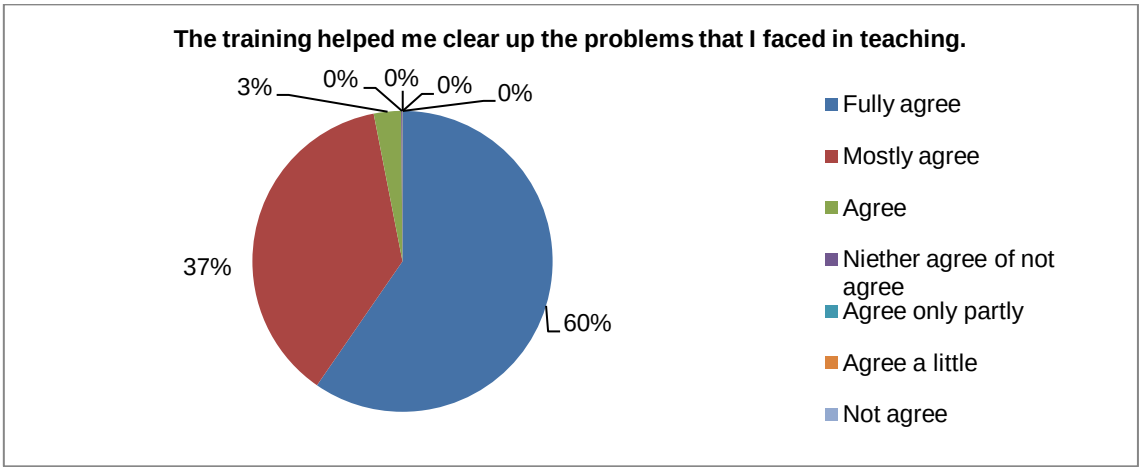
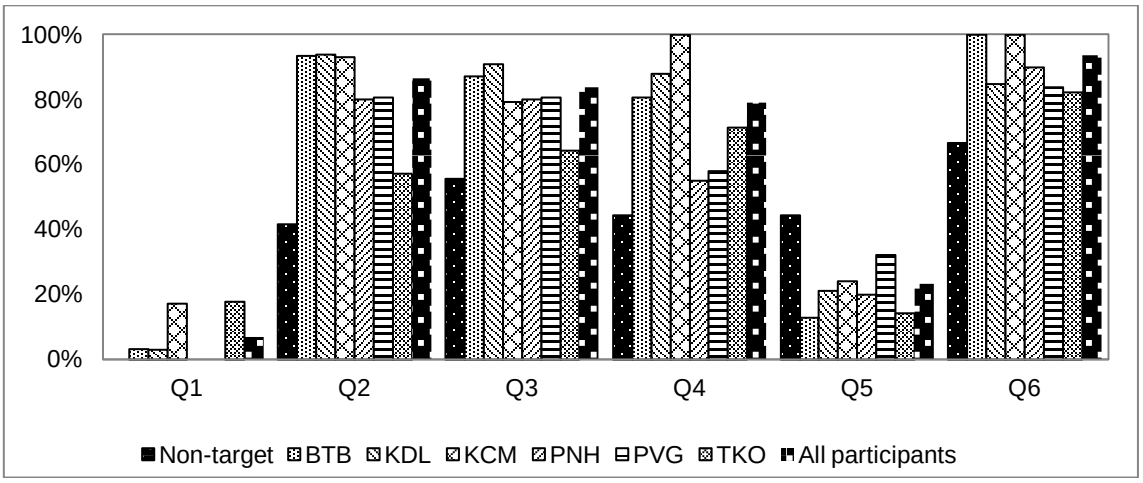


Figure 3-9 Benefit from the Training Program

Following figures indicate the results of the understanding check conducted for the last batch of the participants in the 5th training program. The comprehension test assesses the level of understanding of the participants on the teaching methods as well as subject-wise information. Some questions in this test were the same questions used for the non-target group of teachers in

science and math at the lower secondary level in the end line survey. Therefore, the results can be compared in between the two[15].

As for mathematics, there was a comparison between the target group and the non-target group for all the questions. Accordingly, the target group who participated in the training program scored better comparing the non-target group in all the questions except for one question (Q5: statistical mean). In the meanwhile, the results show fluctuation in the correct answer rate according to the regions, and significantly low rate of correct answer for Q1 (Parallel lines and perpendicular lines) and Q5 (Statistical mean).

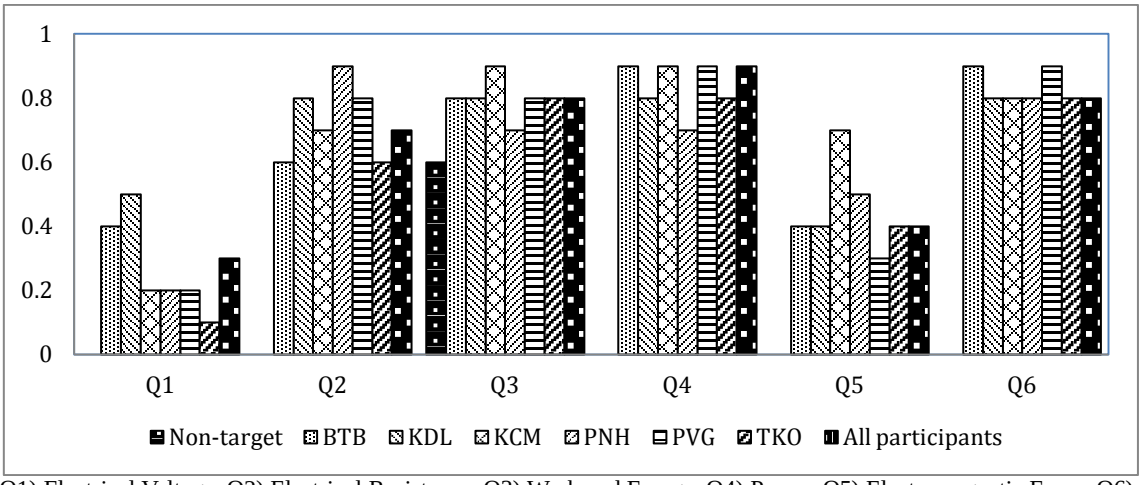


Q1) Parallel lines, perpendicular lines, Q2) Two dimensional geometric shapes, Q3) Proportion and percent, Q4) Lines and Special Segments Intersecting in a Triangle, Q5) Statistical Mean, Q6) Circles and Lines. Respondents: Non-target group 12 for Grade 7 questions, 9 for Grade 8 questions, and 9 for Grade 9 questions. 31 for Battambang (BTB), 33 for Kandal (KDL), 29 for kampong Cham (KCM), 20 for Phnom Penh (PNH), 31 for Prey Veng (PVG), 28 forTakeo (TKO), 172 in total (All participants).

Figure 3-10 Level of Understanding by the Training Participants: Mathematics

For Physics, we could only compare the results between the target group and non-target group against Q3 (Work and Energy). The training participants scored 20% higher than that of non-target group. It was striking to learn that many respondents could not answer Q1 (Electrical Voltage) and Q5 (Electromagnetic Force) correctly while they could answer other questions relatively well.

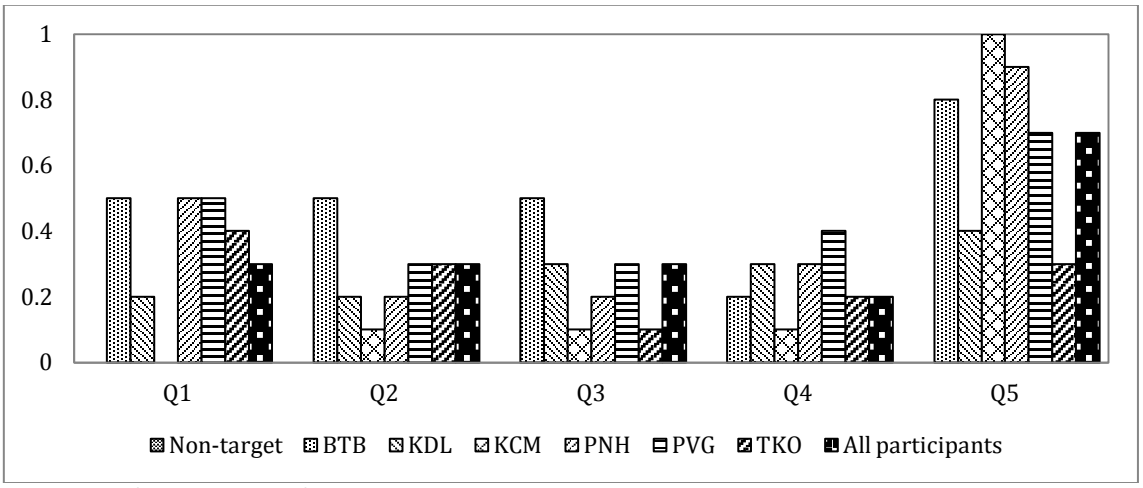
[15] No bar in the graph means zero % of correct answer.



Q1) Electrical Voltage, Q2) Electrical Resistance, Q3) Work and Energy, Q4) Power, Q5) Electromagnetic Force, Q6) Electromagnetic Induction. Respondents: 9 for non-target group, 31 for BTB, 32 for KDl, 28 for KCM, 21 for PNH, 30 for PVG, 28 for TKO, 170 in total (All participants).

Figure 3-11 Level of Understanding by the Training Participants: Physics

For Chemistry, we could only compare the results between the target group and non-target group against Q4 (Carbon). The non-target region group scored zero for Q4 (thus it does not show in the figure below) while 20 % of the target group answered correctly. Apart from Q5 (Oxygen), the overall correct answer rate was quite low. This could be explained by the fact that it must have been difficult to select one correct answer among others as some of the options might not necessarily be entirely wrong[16]. Those questions (except Q5) were related to teaching methods, thus there was no clear cut answer. In Kampong Cham, majority of the respondents selected more than one answer for each question and their answers became invalid. Accordingly, the percentage of correct answers was lower than that of other regions.

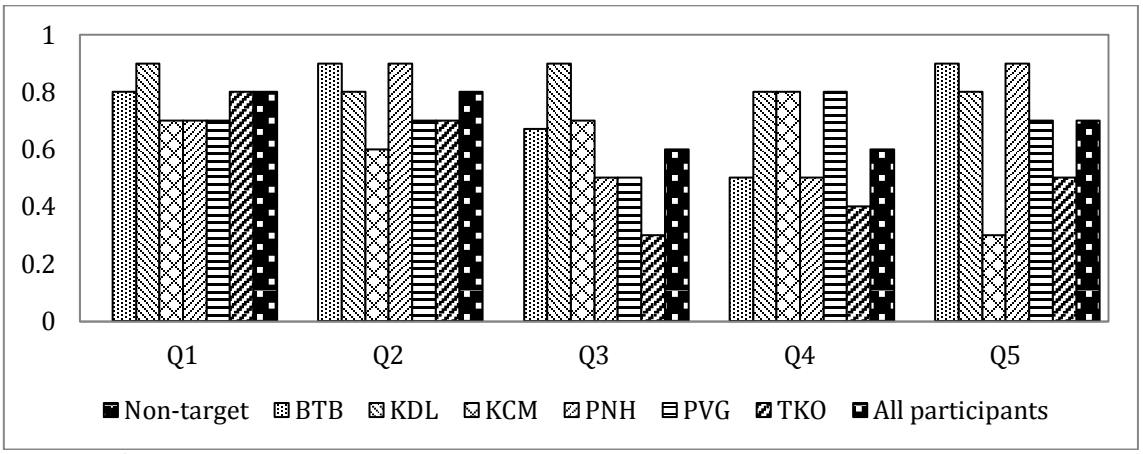


Q1) Factors of Phase Change of a Substance, Q2) Mixture, Q3) Mixture Separation, Q4) Carbon, Q5) Oxygen. Respondents: 6 for non-target group, 31 for BTB, 34 for KDL, 28 for KCM, 19 for PNH, 31 for PVG, 28 for TKO, 171 in total (All participants).

Figure 3-12 Level of Understanding by the Training Participants: Chemistry

[16] Example; Question: Choose the most appropriate activity from the following activities (a)-(d) in this content "Factors of phase change of a substance". Correct answer: Students conducts a few experiments on typical physical changes and chemical changes, and discuss on the characteristics of phase changes and chemical changes. Other option: Students discuss to classify the examples of physical changes and chemical changes, which was not the entire wrong.

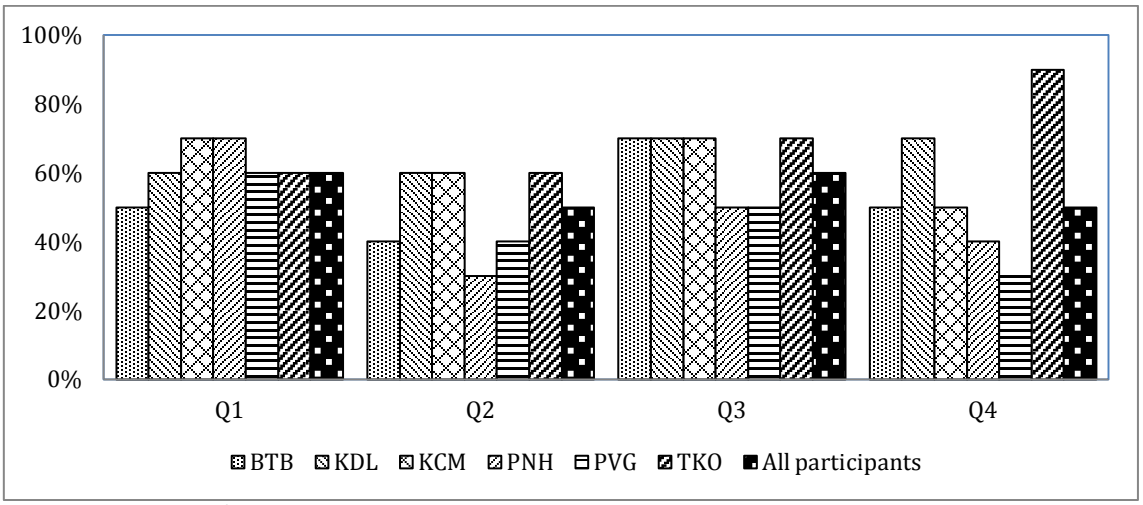
For Biology, we could only compare the results between the target group and non-target group against Q3 (Transport System). The non-target region group scored zero for Q3 (thus it does not show in the figure below) while 60 % of the target group on average answered correctly. While the percentage of correct answers was 60% for Q3 and Q4 (Peripheral Nervous System), for other questions, it was around 80% even though the figure varies according to the region.



Q1) Cells of Plants, Q2) Cell Respiration, Q3) Transport System, Q4) Peripheral Nervous System, Q5) Immune System. Respondents: 8 for non-target group, 30 for BTB, 33 for KDL, 29 for KCM, 21 for PNH, 31 for PVG, 28 for TKO, 172 in total (All participants).

Figure 3-13 Level of Understanding by the Training Participants: Biology

For earth science, we could not compare the results as there was no common question, based on which the comparison could have been made. The overall percentage of correct answer is between 50 to 60%, and there was not much fluctuation observed among different questions.



Q1) Rotating Motion of the Earth, Q2) Earth's Characteristics, Q3) Earthquake, Q4) Mineral and Fossil Fuel. Respondents: 31 for BTB, 34 for KDL, 29 for PNH, 31 for PVG, 28 for TKO, 171 in total (All participants).

Figure 3-14 Level of Understanding by the Training Participants: Earth Science

Reviewing the results of the questionnaire, it seems like that the certain degree of impact by the training program can be confirmed. Indeed, apart from one question in Mathematics, the overall percentage of correct answers by the training participants was much higher than that of the non-target provincial group. Having said that, even the test was conducted right after the training program, it did not show a high percentage of correct answers in general. According to

the RTTC trainers who led the training sessions, and the WG members from MoEYS who monitored the progress of the training program, it was very challenging to manage time because the participants spent much more time in understanding the basics of the Teacher's Guide, than in discussing how to use it effectively in their lessons. This is due to the fact that the participants' level of knowledge in subjects covered by the Teacher's Guide was much lower than expected. Accordingly, it is important and very much needed to provide continuous support for INSET.

3.5 School Director Meeting

TTD in collaboration with POEs held school director meeting four times. For these meetings, school directors (or vice school directors) of all the lower secondary schools in the target provinces were invited. Originally, there was no budget allocation for the meetings since the agenda from this Project was supposed to be added on to the agenda of the regular school director meetings organized by POE. However, it was reported that the regular school director meetings were already overloaded with many items on its agenda. Therefore, from the 2nd year of the Project, it was decided that the Project would allocate budget for the school director meetings and organize them separately. According to POE, the school director meetings helped the implementation of the training program tremendously as it gave an opportunity for them to understand the purpose of the training program and the importance of the Teacher's Guide. Subsequently, it became easier for POE to encourage their participation in the training program and to advocate for the effective usage of the Teacher's Guide. In addition, it is assumed that the school director meetings have contributed to the high participation rate of the training program as they have provided an opportunity to demonstrate healthy competition among schools, which was fueled by the participation rate of the training program shared by the Project at the meetings.

No.	Implementation Date	Main Agenda
1st	December 2014	Purpose of the Project, roles and responsibilities of the school directors, INSET participation rate, checking on the level of utilization of the Teacher's Guide.
2nd	February to March 2015	Announcement of the 4th INSET and its schedule, collect information on the number of math and science teachers, checking on the level of utilization of the Teacher's Guide
3th	September 2015	Announcement of the 5th INSET and its schedule, checking on the level of utilization of the Teacher's Guide, sharing of the results of the Impact Survey
4th	May 2016 (March 2016 only for Phnom Penh)	Information sharing of the results on the 5th INSET, distribution of the Teacher's Guide, announcement on the distribution of the Teacher's Guide and its utilization

3.6 Monitoring and Evaluation

The Project conducted three major surveys to monitor and evaluate the impact of the Project, such as a Baseline survey, an Impact survey and an End line survey as shown below. Questionnaires for school directors and teachers in mathematics and science, and students' test for grade 8 and grade 9 students were conducted. A local company called BN Consult was sub-contracted to take care of the data collections through conducting questionnaires and tests at schools, as well as to input data gathered through such school-level surveys into the required excel sheets. The Project supervised the entire survey process, and analyzed the collected data sets.

3.6.1 Baseline Survey

Baseline Survey was conducted from November 2013 to March 2014. The data collection at schools took place from November to December 2013, just after the 1st INSET. At that time, most of the Teacher's Guide that was distributed at the INSET had not yet been used at lessons. The survey was conducted against all the RTTC cooperative schools (37 schools in 2013-2014 school year), 6 general schools from the Project target provinces, and 6 general schools from the non-target provinces. Kampong Speu and Siem Reap were selected as the non-target provinces, as their social and economic status was similar to those of the target provinces.

3.6.2 Impact Survey

Impact Survey was conducted from January 2015 to July 2015 (the data collection at schools was done from January to February 2015). The survey was conducted against all the RTTC cooperative schools (41 schools in 2014-2015 school year), 6 general schools from the Project target provinces, and 6 general schools from the non-target provinces. And a comparative analysis was made with the results from this survey against the results of the Baseline Survey.

3.6.3 End line Survey

End line Survey was conducted from November 2015 to April 2016 (the data collection at schools was done from December 2015 to January 2016). The survey was conducted against all the RTTC cooperative schools (34 schools in 2015-2016 school year), 6 general schools from the Project target provinces, and 6 general schools from the non-target provinces. And a comparative analysis was made with the results from this survey against the results of the Baseline Survey and the Impact Survey.

3.7 Monitoring Activities

Apart from the above mentioned monitoring and evaluation, the Project also conducted monitoring activities, through which usability of the Teacher's Guide and the level of its usage at schools were monitored. There were three different monitoring activities.

<A monitoring activity in conjunction with the regular monitoring by POE inspectors>
As part of their duties, POE inspectors regularly conduct school monitoring activities. In conjunction with the regular school monitoring activities, POE inspectors were asked to assess how well the Teacher's Guide was distributed and shared among teachers within a school, and how it had been used in the daily lessons. However, monitoring activities by POE inspectors are usually conducted only twice a year or so, which does not provide timely feedbacks to the Project. Accordingly, the following other monitoring activities were conducted.

＜Additional monitoring activities by POE inspectors>
POE inspectors were asked to conduct additional monitoring activities in four selected schools in each target province, in order to assess the current level of usage of the Teacher's Guide (vol. 1 - 3) and to identify the detailed areas for improvements by subject and by lesson after using the Teacher's Guide. The feedbacks received from this monitoring activity were reviewed by NIE trainers and they were used to revise the Teacher's Guide vol. 1 - 3. For the Teacher's Guide vol. 4 - 5, POE inspectors were too busy to conduct additional monitoring activities. Instead, NIE trainers directly conducted monitoring at the INSET. They gathered useful remarks and suggestions from the participants with regard to how the Teacher's Guide can be improved and how well the points can be explained in the Teacher's Guide. The feedbacks are incorporated into the following version of the Teacher's Guide.

＜Additional monitoring activities by the JICA Project Team and POE inspectors>

The JICA Project Team in coordination with POE conducted additional monitoring activities mainly to the target schools for the Impact Survey. Especially for the RTTC cooperative schools, the JICA Project Team and POE visited each and every school and shared the results of the Impact Survey. By visiting the school individually, the Project could grasp the real situation of the school, and promoted the usage of the Teacher's Guide. Based on the above- mentioned monitoring activities, following points were identified to be followed up;

- Overall allocation of hours for teaching science is too limited to implement experiments and activities suggested in the Teacher's Guide. As of now, 2 hours per week were allocated for Physics (In Phnom Penh, only one hour is allocated for Physics), 2 hours per week for Biology (In Phnom Penh, only one hour is allocated for Biology), 1 hour per week for Chemistry and 1 hour per week for Earth Science.
- It is challenging to conduct small tests introduced in the Teacher's Guide due to the time constraints.
- Teachers are hesitant about teaching lessons with correction of mistakes found in textbooks. (They misunderstood that textbooks had been approved by MoEYS, while the Teacher's Guide had not. Thus, even when they find a mistake in textbook, they do not feel comfortable enough to correct such mistake.)
- Students in general do not have a habit of doing homework and/or reviewing the lessons learned at home. Therefore, it is more challenging for them to acquire a habit of studying by themselves.
- Grade 9 exam is now offered at an individual school. (Each school also prepares the exam questions independently.) Therefore, some students tend to be more relaxed in studying and not to stay focused on their study.
- There are some students who cannot even understand the Khmer language (few % of the lower secondary students), which hinders their understanding.

In response to the above, the Project suggested teachers to pick and choose the parts of the Teacher's Guide most relevant for students, based on the progress and the level of understanding of the students. Also, the Project confirmed that the Teacher's Guide was approved by MoEYS, so the teachers are free to use the Teacher's Guide without hesitation and to correct mistakes in textbooks, which were pointed out by the Teacher's Guide. These feedbacks received through intensive communications with the local schools are regularly reflected to the implementation of the Project to make it better by sharing such information with TTD and POE.

3.8 POE Meeting

The Project conducted meeting with POE in regular basis to discuss on the schedule of the events (INSET, school director meeting, etc), discuss on solutions for issues occurred during the training program and issues found through school monitoring activities, prepare for school director meeting, and so forth. TTD director (or vice-director) and the Project coordinators from TTD initiated the meeting, and POE directors (or vice-directors), inspectors, and secondary education officers from six target provinces participated in. During the project period, the Project conducted these school director meetings for 24 times.

3.9 PISA for Development

Mr. Koji Takahashi, Team Leader of the Project, participated in the workshop on "PISA for development" (PfD) held in Montreal in Canada from 29 September to 3 October 2014. In the workshop, the countries who would participate in the PfD program of OECD got together and discussed the issues surrounding the implementation of PfD, focusing on the survey on

out-of-school 15 year old children. In the workshop, Mr. Koji Takahashi supported two representatives of Cambodia to provide OECD with a huge amount of data and information that would be used to assess the capacity development needs of Cambodia. After this workshop in Montreal, the Project organized a workshop in Phnom Penh to share the views on PISA for Development. The Project also shared the result of the Baseline survey conducted by the Project to understand the current status of mathematics and science education in Cambodia and to discuss on further measures to be taken, in relation to PISA.

3.10 Support for Policy Development

The Project contributed to the development of Education Strategic Plan (ESP) 2014-2018, Teacher Policy Action Plan (TPAP), and the curriculum review process of Curriculum Review Committee. It is worth mentioning that JICA Cambodia Office provided financial support to the development of TPAP through employment of a local consultant. The JICA Project Team worked very closely with the consultant and provided technical inputs into the development process. TPAP was officially approved by MoEYS in January 2015. In the TPAP, importance of the "Teacher's Guide development for priority subjects (Khmer, history, math, science)[17]", and "Distribute available textbooks and teacher guides to all schools across all grades[18]", which are closely related to the activities of this Project, were officially recognized. Accordingly, the JICA Project Team supported the implementation of the TPAP, as one of the members of TPAP Task Force.

3.11 Joint Coordination Committee Meeting

During the Project period, the Project organized JCC meeting, chaired by H.E Nath Bunroeun, three times. Schedule and main discussion points were as follows.

	Schedule	Main points
1st	8 December 2014	Report on the Project progress, Suggestions from JICA Consultation Mission for further improvements
2nd	11 August 2015	Report on the Project progress, Revision of the PDM
3rd	9 May 2016	Evaluation of the Project with JICA evaluation team

3.12 Collaboration with JOCV and SV

The Project proactively collaborated with JOCV and SV. They are invited to participate in WG seminars, POE meetings and the major Project activities such as the INSET, and requested for their feedback. In particular, at the training program, JOCV and SV provided invaluable supports for the experiments and activities conducted by RTTC trainers and feedback with regard to the level of understanding demonstrated by the participants. They also shared their valuable inputs and advice on the Teacher's Guide development. Apart from those occasions, JOCV and SV contributed to the Project implementation by sharing information about the regular RTTC lessons and the current level of utilization of the Teacher's Guide in teaching practices, etc.

[17] MoEYS (2015) Teacher Policy Action Plan, page 5
[18] MoEYS (2015) Teacher Policy Action Plan, page 18

4. Subcontract

The project hired local subcontractors for three areas of works.

4.1 Teacher's Guide Development

The Project contracted following NIE trainers as individual consultants for Teacher's Guide development.

1. Mathematics: Mr. Thai Heng
2. Physics: Mr. Ngor Penglong/ Ms.Khek Samnang (substitute)
3. Chemistry: Mr. Set Seng
4. Biology: Ms. Hour Khim
5. Earth Science: Ms. Peng Tithsothy

They were selected as they have 1) experiences of involvement in STEPSAM1/2, 2) enough knowledge of the subject, 3) masters or higher degree in the field of science and mathematics education, and 4) they are fluent in English.

They were responsible for the following tasks.

- Translate and localize the Teacher's Guide based on the English draft developed by the JICA Project Team
- Reflect comments obtained through WG seminar to the Teacher's Guide
- Reflect comments obtained through INSET and monitoring to the Teacher's Guide
- Finalize all of the Teacher's Guide

4.2 Administrative Works and Cash Management of Training

The Project contracted Forval Cambodia Co., Ltd for administrative works and cash management for all of 5 INSET. They completed their tasks successfully without any critical problems.

They were responsible for the following tasks.

- Dispatch a site leader and two staff members to each training site
- Purchase necessary training materials (experimental materials, stationary, etc)
- Check the attendance of the participants and trainers
- Support trainers to distribute training materials
- Collect questionnaires during the training and input data into excel sheet
- Make payment of allowance and accommodation to the participants and trainers

4.3 Baseline Survey, Impact Survey, and End line Survey

The Project contracted BN Consult for data collection and data input of the baseline survey, the impact survey and the end line survey. They completed their tasks successfully without any critical problems and submitted sets of data.

They were responsible for the following tasks.

- Conduct pre-test to verify the tests and questionnaires developed by the Project
- Modify the means of data collection based on the result of pre-test
- Coordinate with school directors of target schools for school visit
- Conduct test and questionnaire survey at target schools
- Input data into excel sheets provided by the Project

- Submit basic information of the respondents (name of schools, number of respondents, etc)

5. Achievement

5.1 Achievement of the PDM

JICA evaluation team examined the achievements of the Project from 18 April to 9 May 2016, and jointly concluded the following achievements with JCC members on 9 May 2016.

5.1.1 Achievement of the Project Purpose

The Project purpose "Foundation for MoEYS to support teachers for science and mathematics lesson improvement at the lower secondary level is strengthened" was evaluated as **"achieved"** based on the following evidences.

Indicator 1) Teacher's Guide for science and mathematics lesson improvement at the lower secondary level is approved by MoEYS.

➔ Teacher's Guide was approved by MoEYS at the consultation meeting held on 12 January 2016, chaired by H.E Nath Bunroeun.

Indicator 2) In-service training contents to introduce Teacher's Guide to lower secondary science and mathematics teachers is approved by MoEYS.

➔ The package of training contents, including the "implementation manual for trainers and POE" and training handouts, for each INSET was approved by MoEYS at WG seminar held every before the set of training program. WG members from MoEYS and TTD were gradually involved in the process of developing the training packages so as to improve their capacity of training planning and preparation. Additionally, those approved training packages are integrated into the training materials of ESDP3 and begun to be used.

5.1.2 Achievement of the Output 1

The Output 1 "Teacher's Guide for science and mathematics lesson improvement at the lower secondary level is developed" was evaluated as **"achieved"** based on the following evidences.

Indicator 1-1) Developed Teacher's Guide

➔ The Project developed the Teacher's Guide covering 123 lessons in total (corresponding to nearly 40 % of all the lessons of the textbook in mathematics and nearly 70 % of all the lessons in science textbook). Following is the list of number of lessons covered in each of 5 subjects; physics, chemistry, biology, earth science and mathematics. The coverage was much more than the original plan, which was 75 lessons; approximately 5 lessons for each of 5 subjects for 3 grades.

Table 5-1 Number of Lessons Covered by the Teacher's Guide

Subject	Grade 7	Grade 8	Grade 9
Mathematics	7/22	7/18	7/18
Physics	10/16	9/15	8/19
Chemistry	6/6	8/8	8/9
Biology	9/16	9/15	9/13
Earth science	9/11	8/13	9/12

Indicator 1-2) Improvement in teaching at the cooperative schools for chapters where Teacher's Guide covers: More than 60% of teachers show positive changes in more than 60% of viewpoints.

➔ 73.2% of the teachers who responded to the questionnaire at end line survey showed positive changes in more than 60% of viewpoints. They were asked whether they adopted the ideas and activities introduced in Teacher's Guide at their lessons. There are 4 choices of answers from A to D as in table below, and the option A was considered as a "positive change."

Choice	Behavioural Changes	Answer Options
A	Positive changes	* I started it after STEPSAM3 training. * I did it more after STEPSAM3 training
B	Positive and no change	* I did it equally before and after STEPSAM3 training. * I did it both before and after STEPSAM3 training.
C	Negative and no change	* I did not do it before and after STEPSAM3 training. * I did not do it both before and after STEPSAM3 training.
D	Negative changes	* I did it less after STEPSAM3 training. * I did it before STEPSAM3 training, but now do not.

Checking through their answers, valid respondents who chose "A" or "C" or "D" in at least one of the questions were identified (Teachers who only chose "B" was excluded as he/she already performed well from the beginning and cannot show positive changes). Percentage of positive changes was identified by the number of questions choosing "A" among the number of all answers ("A" or "C" or "D") of valid respondent. Then the number of valid respondents who chose "A" in more than 60% of the viewpoints was counted (A÷(A+C+D)). Table below shows the result of the analysis.

Table 5-2 Percentage of Teachers showed Positive Changes in more than 60% of viewpoints

		Math	Phy	Che	Bio	E.S	Total	%
PNH	Valid Respondents	32	23	15	15	9	94	
	A/(A+C+D) >=60%	18	11	7	9	4	49	52.1%
BTB	Valid Respondents	37	19	20	17	8	101	
	A/(A+C+D) >=60%	32	15	13	13	8	81	80.2%
KCM	Valid Respondents	29	18	6	19	11	83	
	A/(A+C+D) >=60%	24	16	4	13	10	67	80.7%
PVG	Valid Respondents	36	19	18	21	23	117	
	A/(A+C+D) >=60%	33	14	14	13	16	90	76.9%
TKO	Valid Respondents	12	11	14	13	11	61	
	A/(A+C+D) >=60%	9	7	9	8	11	44	72.1%
KDL	Valid Respondents	17	14	8	6	7	52	
	A/(A+C+D) >=60%	16	12	5	2	6	41	78.8%
Total	Valid Respondents	163	104	81	91	69	**508**	
	A/(A+C+D) >=60%	132	75	52	58	55	**372**	**73.2%**

The valid respondents include teachers from RTTC cooperative schools and general schools. As RTTC trainees go to the cooperative schools for practice teaching, if RTTC trainers instruct the trainees to use Teacher's Guide at their practicum, it may give a positive impact on in-service teachers at the cooperative schools. Due to this reason, the positive change at cooperative schools can be better than that of general schools. However the analysis showed

that 73.2% of teachers showed positive changes in more than 60% of viewpoints, even if we integrated the respondents from cooperative schools and general schools.

5.1.3 Achievement of the Output 2

The Output 2 "The capacity of RTTC trainers for science and mathematics lesson improvement at the lower secondary level is enhanced" was evaluated as **"achieved"** based on the following evidences.

Indicator 2-1) Evaluation of RTTC trainers on in-service training

➔ Improvement in the capacity of RTTC trainers was confirmed in the questionnaire survey using the Check-list conducted after the 5th INSET. Respondents were required to self-evaluate in the scale of 7 (1: Very low-7: Very high) for the following aspects;

A) Subject knowledge: Compare your subject knowledge on the topics with which Teacher's Guide has dealt.
B) Skills on the subject matters: Compare your skills related to your subject (e.g., drawing figures, preparing teaching materials, conducting experiments, etc.).
C) Attitude for further learning: Compare your motivation for learning the subject matters.
D) Proficiency in teaching using Teacher's Guide: Compare your skills to explain to schoolteachers in service the knowledge and skills given in Teacher's Guide.
E) Subject knowledge of school teachers in INSET: Compare the subject knowledge of school teachers who have continuously participated in INSET.

71 RTTC trainers[19] responded, and the results were as follows.

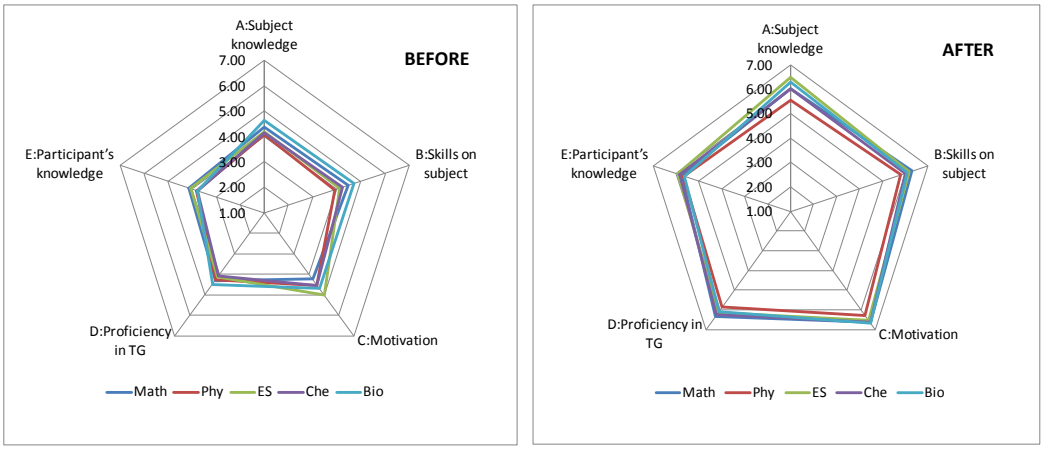


Figure 5-1 Results of RTTC Trainers' Self-evaluation

Table 5-3 Average Score of RTTC Trainers' Self-evaluation

	A	B	C	D	E	All
Before	4.28	4.28	4.62	4.25	3.92	4.27
After	6.07	6.07	6.52	6.11	5.77	6.11
Difference	1.79	1.79	1.90	1.86	1.86	1.84

[19] The number of RTTC trainers includes vice-directors of RTTC and a former RTTC trainer who moved to POE, but all of them were involved in the INSET as trainers.

As shown in the Figure and the Table, RTTC trainers evaluated that their capacity had improved significantly in all of the aspects and the difference of the average between "Before" and "After" marked 1.84pt. There were slight difference for the subject knowledge in between five subjects, but the difference was very little. And there were no significant difference between provinces.

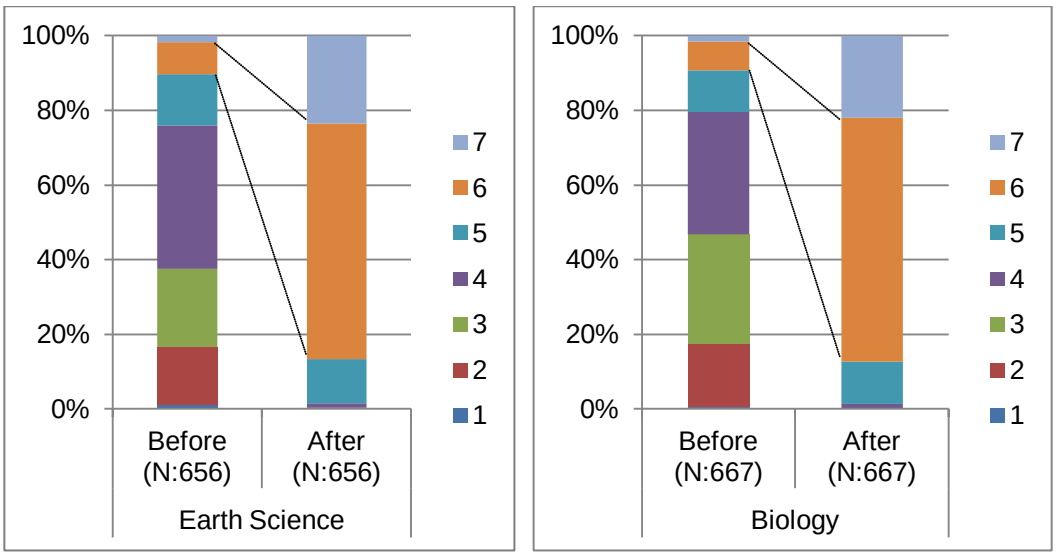
Indicator 2-2) Changes in participants' attitude toward lesson improvement through in-service training programmes.

➔ Positive changes in participants attitude toward lesson improvement was clearly observed by the questionnaire conducted at the 5th INSET. The INSET participants assessed their changes in the scale of 7 (1: Very low-7: Very high), by comparing before and after the training program in the following two aspects;

A) Motivation to give students additional knowledge and/or practice on mathematics/ science
B) Motivation to correct errors and mistakes in the mathematics and science textbooks

And the results for the aspect A and B were as follows, respectively.

As shown in the Figure below, the number of participants who evaluated the Level 7 and 6 was significantly increased from about 10% to about 90% in all of the subjects.



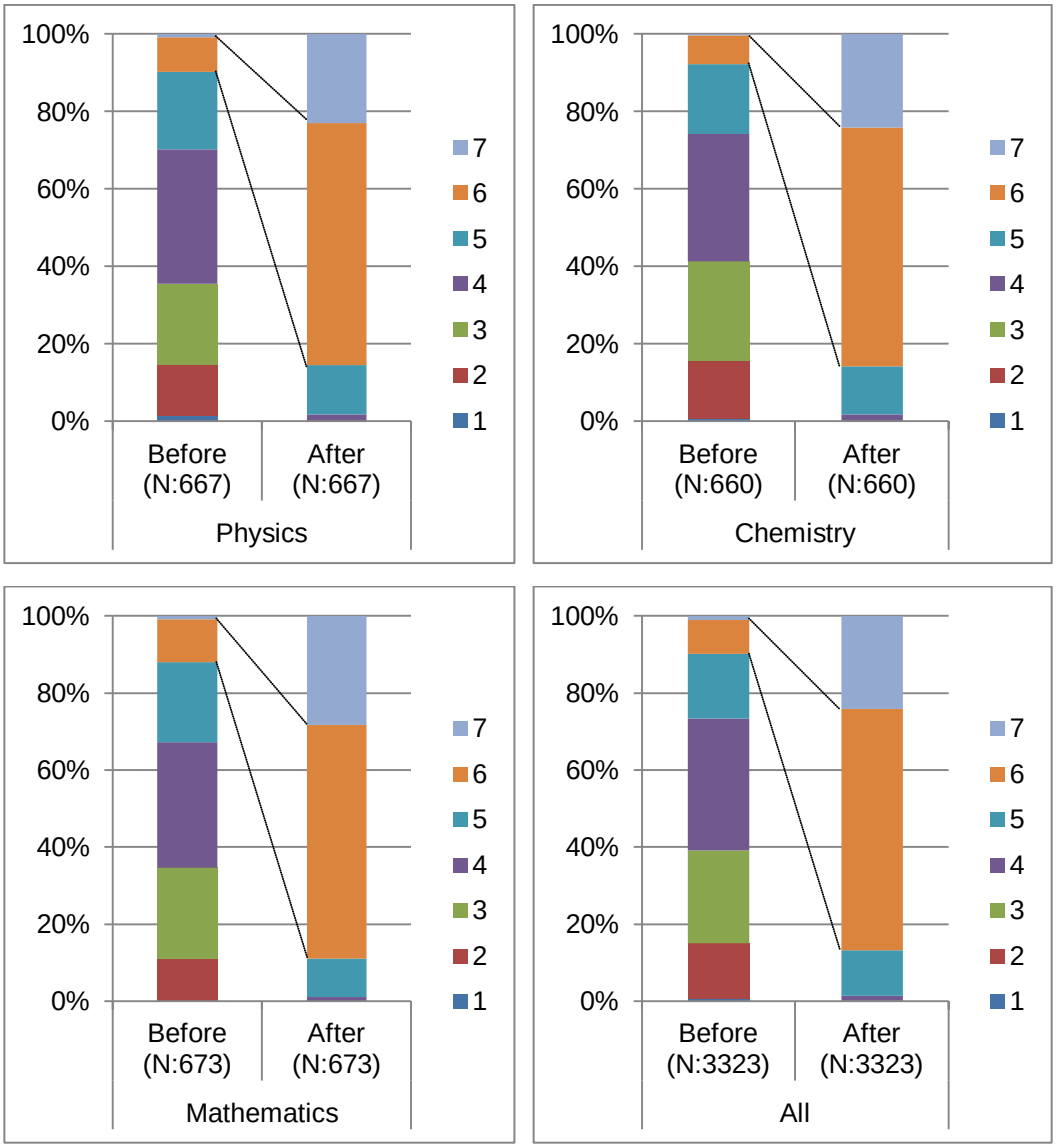


Figure 5-2 Results of INSET Participants' Self-evaluation: Aspect A

As shown in the Figure below, the number of participants who evaluated the Level 7 and 6 was significantly increased from about 10% to 80% - 90% in all of the subjects. These results show that INSET and Teacher's Guide impact on teachers' attitude toward lesson improvement.

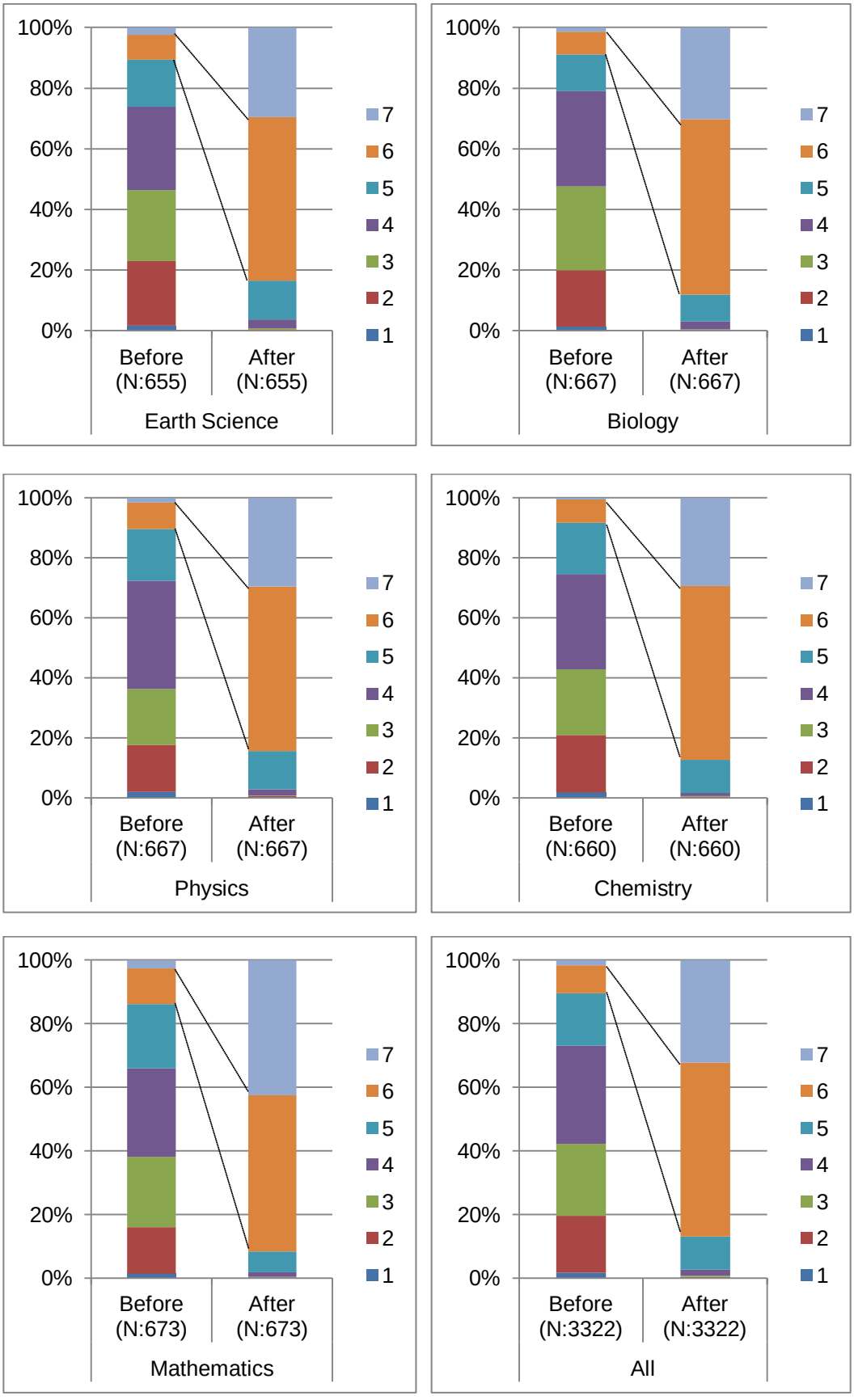


Figure 5-3 Results of INSET Participants' Self-evaluation: Aspect B

5.2 Deliverables

The Project developed the following deliverables.

5.2.1 Technical Documents

Table 5-4 List of Technical Document

Year	No.	Title	# of submission to MoEYS
1st	1	Baseline Survey Report	2 copies
2nd	2	Impact Survey Report	
	3	End line Survey Report	
	4	Grade 7 Teacher's Guide for mathematics	As listed in Table 3-4
	5	Grade 8 Teacher's Guide for mathematics	
	6	Grade 9 Teacher's Guide for mathematics	
	7	Grade 7 Teacher's Guide for Physics	
	8	Grade 8 Teacher's Guide for Physics	
	9	Grade 9 Teacher's Guide for Physics	
	10	Grade 7 Teacher's Guide for Chemistry	
	11	Grade 8 Teacher's Guide for Chemistry	
	12	Grade 9 Teacher's Guide for Chemistry	
	13	Grade 7 Teacher's Guide for Biology	
	14	Grade 8 Teacher's Guide for Biology	
	15	Grade 9 Teacher's Guide for Biology	
	16	Grade 7 Teacher's Guide for Earth Science	
	17	Grade 8 Teacher's Guide for Earth Science	
	18	Grade 9 Teacher's Guide for Earth Science	

5.2.2 Reports

Table 5-5 List of Report

Year	No.	Title	# of submission to MoEYS
1st	1	Inception Report	2 copies
	2	Project Progress Report Vol.1	2 copies
	3	Project Progress Report Vol.2	2 copies
2nd	4	Project Progress Report Vol.3	2 copies
	5	Project Progress Report Vol.4	2 copies
	6	Mid-term Progress Report	(Japanese only)
	7	Project Completion Report	2 copies

6. Lessons Learned and Suggestions

During the course of three years of the project implementation, several problems were identified. Even now, some of the problems remain, however, it is commendable to state that MoEYS and some development partners (DPs) highly valued the Project's achievements, and employed some of the lessons learned from the Project for their own initiatives. Some key points can be identified for the successful implementation of the Project within such a short period of time. The following lessons learned and suggestions are to be shared for the future interventions in the education sector in Cambodia.

6.1 Project Management

Good relationships with MoEYS and relevant DPs, continuous improvement of the project activities, efficient management by outsourcing administrative tasks to sub-contractors, were the factors contributed to the successful project management.

It should be noted that long-term good relationship with MoEYS and with relevant DPs since the time of STEPSAM1 significantly contributed to the Project to bear fruits in short-term. For example, the Project was strongly initiated by TTD and POEs with a common understanding that the Project is belong to MoEYS and the JICA is providing technical and financial support. H.E Nath Bunroeun and TTD director repeated it at seminars and meetings so as to nurture the common understanding among WG members and INSET participants. And they showed strong leadership to overcome challenging situations during the Project. Additionally, the MoEYS and the Ministry of Economic and Finance determined and approved to disseminate the Teacher's Guide to those remaining 19 provinces which were out of the Project target area, thanks to the good collaboration between the JICA Project Team and TTD, Department of Finance, and other relevant departments of MoEYS, strongly supported by H.E Minister's initiative. Furthermore, long-term cooperation between other DPs significantly contributed to utilize the assets of STEPSAM (STEPSAM1, STEPSAM2, and STEPSAM3) for more improvements, such as that ESDP3 uses the Teacher's Guide and the human resources developed by the Project for their further activities.

As part of the Project, the JICA Project Team mobilized its experts in flexible manner to achieve the better outcomes, by carefully monitoring the progress of the Project. For example, one specialist was specifically designated to be in charge of all science education, with four different subjects in science being taught. Furthermore, the science specialist became onboard at the local office in Cambodia from the 2nd year, and acted as an intermediary between NIE trainers and the other JICA experts. He paid special attention to consistency, in regards to the Teacher's Guide in the different subjects, and ensured that quality work was delivered by the Teacher's Guide until the time for the final printing. While the Teacher's Guide was written in Khmer, it was an extra advantage to have the science specialist, whom could review the Khmer documents directly as he had JOCV experience in Cambodia. By having him in place, it was possible to maintain the consistency of the Teacher's Guide among the different subjects in science, and avoid unwanted discrepancies in terminology and its structure. In addition, it is considered as one of the key elements in leading the Project to a successful conclusion that the other members of the JICA Project Team also responded to the needs of their counterparts, and the progress of the Project, by being flexible in their work assignments. Furthermore, the Project implemented additional activities, such as school director meetings and school monitoring activities, which significantly contributed to the better implementation of the Project.

It is also worth noting that outsourcing several tasks reduced the Project's workload and increased the operational efficiency of the Project. For example, administrative tasks of the INSET, data collection and data input of the surveys, translation and localization of the

Teacher's Guide were outsourced so that the JICA Project Team could focus more on technical support.

6.2 Lessons Learned from the Teacher's Guide Development

In order to assure the quality of Teacher's Guide, the JICA experts prepared its first draft in English, and then the NIE trainers translated it into Khmer and localized it with other WG members, considering the Cambodian context. At the same time, the Project judged that the most appropriate areas of capacity building for WG members is not to develop the Teacher's Guide from scratch but to step forward by localizing and improving the quality of the Teacher's Guide. This approach helped not only the Project spend more time for polishing the Teacher's Guide, and but also the WG members concentrate on discussing the ways of instruction and description. As a result, the Project could guarantee the quality of the Teacher's Guide, and WG members also obtained certain ownership on the Teacher's Guide.

Although WG members still need to step forward to be able to independently develop the Teacher's Guide, a strong working relationship built between the NIE trainers and WG members through many times of revisions can contribute to continuous improvement and update of the Teacher's Guide in the future.

6.3 Lessons Learned from the INSET

It was the very first experience for both MoEYS and POEs to organize training programs as big as the ones conducted by the Project (around 3,500 teachers participated in each of the training program). It is worth mentioning that the training programs were implemented successfully with a high level of participation rate and impressive results, thanks to the very commendable level of implementation and the management abilities that the POEs demonstrated. In addition, the logistical support for the implementation of the training programs (such as the distribution of training materials, procurement of training materials, payment of the allowance to the participants, etc.) were efficiently subcontracted locally, which minimized the logistical loads that the Project, POEs, and the RTTC trainers had to otherwise bear. These kinds of tips and know-how that we have learned through the Project will be instrumental for MoEYS in the near future, when MoEYS needs to design and implement new training programs independently.

Another good lesson learned from the Project was the application of the check-lists that were used to ensure the proper implementation of all exercises in each session of the training program. These check-lists that the Project prepared were effective in managing a large number of participants with a different level of abilities and capacities and with a different level of teaching skills of the RTTC trainers.

On the other hand, it was very challenging for the Project to optimize the relationship between the level of participants' basic knowledge, the volume and contents of the Teacher's Guide, and the duration of the training days. Compared to the volume of the Teacher's Guide, duration of the training was relatively short, but still, participants raised many of basic questions due to their limited background knowledge, which sometimes made the RTTC trainers feel difficult to manage the time. However, considering the negative impact on the regular teacher training at RTTCs, the training program couldn't be longer than 2 days. The level of the Teacher's Guide was set to meet the requirement of teachers who are a little advanced than the average; therefore, it was within our estimation that it was not easy for about 30% of the teachers to fully understand the contents of the Teacher's Guide. Therefore, the Project requested schools to send TGLs (Technical Group Leaders) or teachers who can lead the group of teachers in the responsible subject, who are relatively advanced than the other normal teachers to attend the INSET. However, we found some participants who were weak in basics, which may constrain

the active dissemination of the Teacher's Guide at school. It is recommendable for TTD to carefully select relevant teachers to be dispatched to the orientation which TTD will introduce the Teacher's Guide to remaining 19 provinces.

6.4 Capacity Enhancement of the RTTC Trainers

As mentioned earlier in Outcome 2, the Project significantly contributed to the capacity enhancement of the RTTC trainers. It was achieved as they repeated the same training program many times to cover all of the invited school teachers to receive the training. It was very obvious during the training that RTTC trainers significantly improved the quality of their lessons as training goes batch by batch.

Having said this; however, noticeable differences still exist in the abilities and levels of understanding among the RTTC trainers. In order to visualize the current level of understanding of the content of the Teacher's Guides, and to identify the areas for future intervention, an understanding check was conducted for the RTTC trainers[20] to assess their level of understanding of the content from the Teacher's Guides vol.1 to 5, after the 5th WG seminar.

The results of the above mentioned check is as follows: It is noted that due to the small sample size, it is possible that the score of one RTTC trainer can skew the overall result of the total test scores. With this in consideration, it is alarming to see that the average percentage of correct answers does not reach 80% in any subject, as shown below. In earth science, the average percentage of correct answers was only 50.9%. In addition, while the highest percentage of correct answers reached 100% in all the subjects, the lowest percentage of correct answers remained significantly low.

Table 6-1 The Level of Understanding by the RTTC Trainers

subject	Math	Physics	Chemistry	Biology	ES
Average % of correct answer	61.3%	64.7%	71.4%	79.9%	50.9%
Question with Highest % of Correct Answers	100%	100%	100%	100%	100%
Question with Lowest % of Correct Answers	7.1%	11.8%	23.1%	35.3%	5.6%

Following Figures indicate the number of RTTC trainers who answered correctly in each question by subject. Regardless of the subject, there was a huge variation in the level of understanding among different areas. It is imperative to boost our efforts to support the capacity enhancement of the RTTC trainers, since they are expected to be the key players in developing the next generation of teachers as well as providing training programs to in-service teachers. As the Teacher's Guide also can contribute to improve their understanding, RTTC trainers are expected to make efforts for self-improvement by continuously reading and utilizing the Teacher's Guide. Furthermore, it is obvious that the areas in which the test results revealed the unsatisfactory level of understanding by the RTTC trainers require more intensive follow-up training opportunities.

[20] The RTTC trainers are the ones who conducted the training program as trainers, including those who have been transferred to become RTTC vice principals and POE staff members.

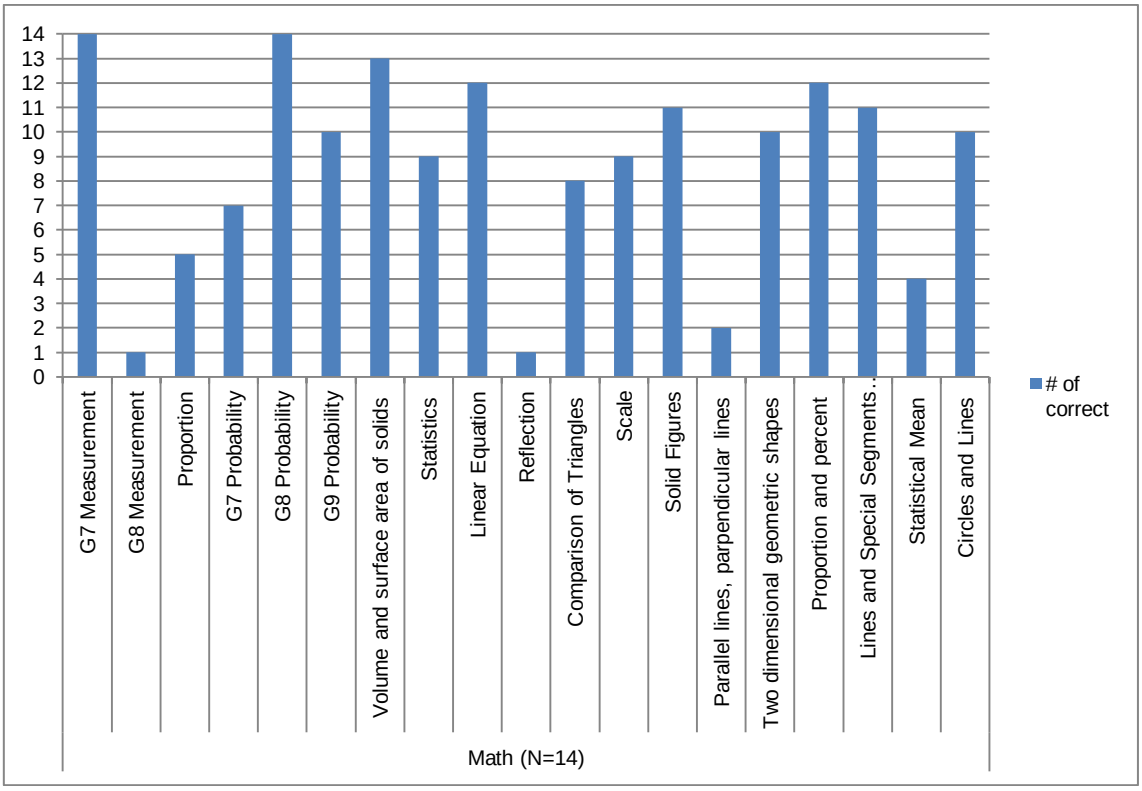


Figure 6-1 # of Trainers who Answered Correctly: Math

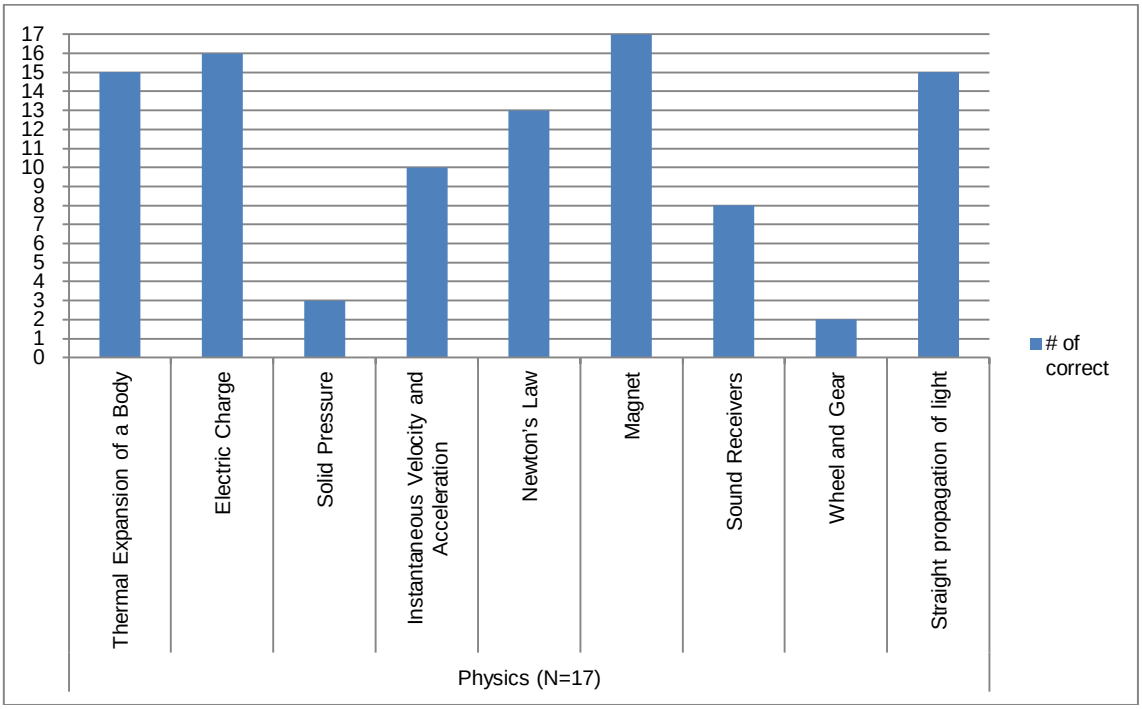


Figure 6-2 # of Trainers who Answered Correctly: Physics

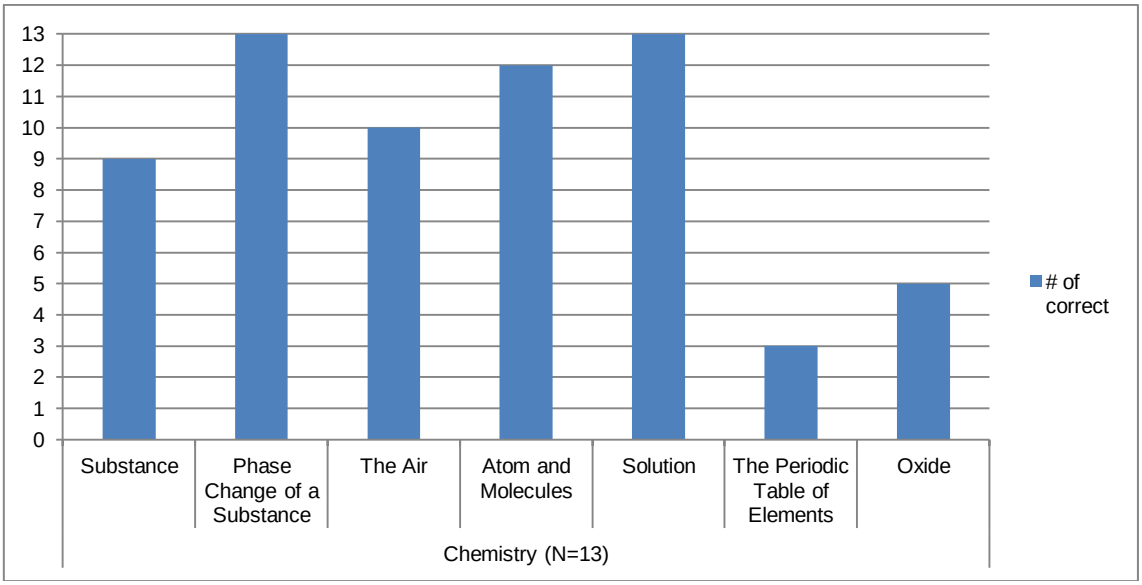


Figure 6-3 # of Trainers who Answered Correctly: Chemistry

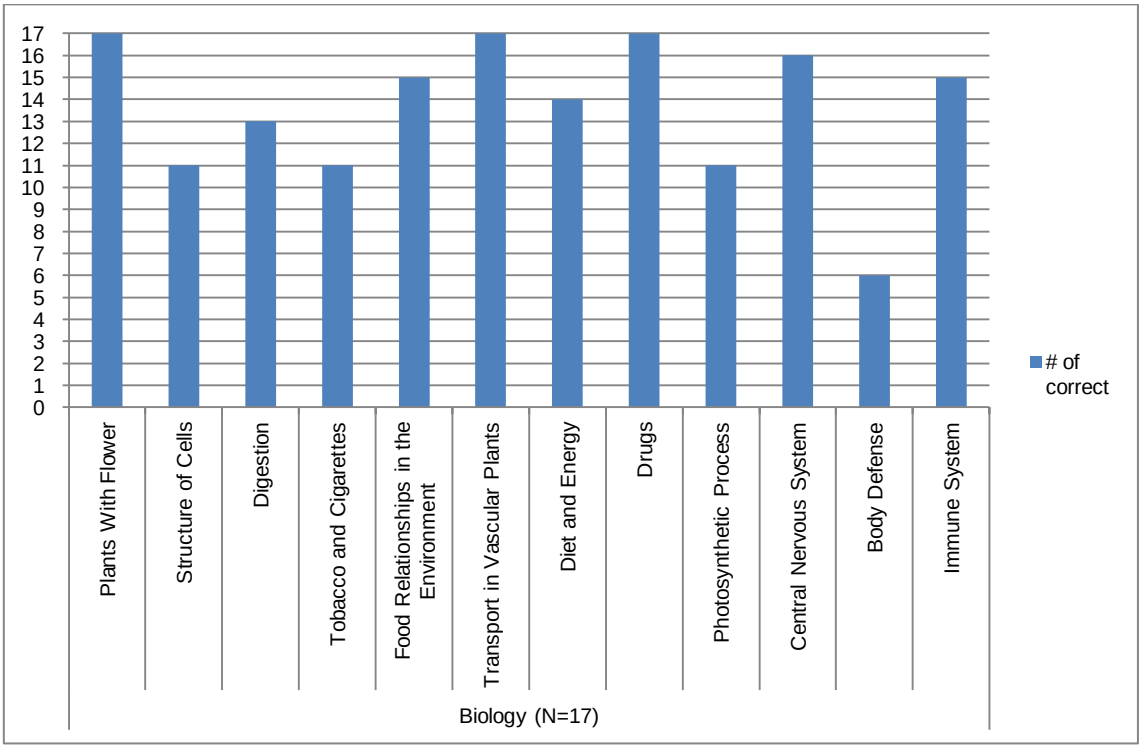


Figure 6-4 # of Trainers who Answered Correctly: Biology

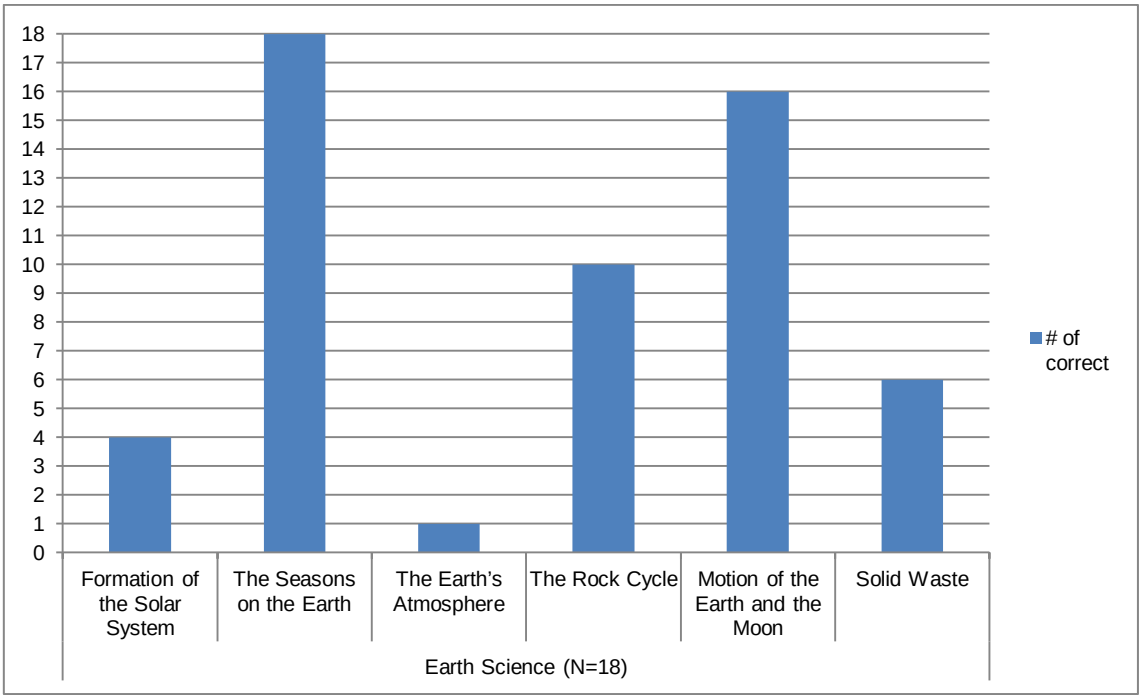


Figure 6-5 # of Trainers who Answered Correctly: Earth Science

6.4.1 Consistency between the Policy and Project Activity

As JICA provided financial support hiring a local consultant for the development of the TPAP, it was easier for the Project to cooperate and collaborate with the TPAP team members. As a result, development of teacher' guide and its dissemination was set as one of the main focuses of the TPAP, which rationalized the Project activity. Furthermore, educational resources developed/enhanced by the Project (the Teacher's Guide and RTTC trainers) will contribute to the successful implementation of the TPAP. As such, it is crucial to have a consistency between the policy and the Project activity, not only for the successful implementation of the Project but also to maximize the impact of the Project.

7. Conclusion

The Project crowns the last of the series of the projects called "STEPSAM", which lasted for more than 15 years in Cambodia. During this period, capacity of NIE trainers has been significantly enhanced through the technical support from the projects as well as their study in Japan. And now, they are the ones who have been taking the key role to improve the science and mathematics education in Cambodia. In the meantime, fundamental issues in the science and mathematics education have been unveiled; such as learning without the understanding of the scientific and mathematical concepts, memorization-oriented teaching in science and mathematics without paying attention to theoretical structures, common misconceptions observed among teachers, etc.

In order to overcome these situations, STEPSAM2 introduced inquiry-based learning into PTTC and RTTC, and STEPSAM3 introduced the Teacher's Guide to change the daily lessons of the teachers. NIE trainers gave instructions to the trainers of PTTC and RTTC in STEPSAM2, and RTTC trainers became INSET trainers for lower secondary teachers in STEPSAM3.

In these 15 years, the series of STEPSAMs have contributed to the human resource development in science and mathematics. At the same time, social conditions around Cambodia have been drastically changed, and qualified human resources for industries who are competitive in the region are more and more required. Under this situation, fundamental improvement of the education, namely, the education reform is pretty much required. Reflecting these urgent needs, H.E. Hang Chuon Naron, the Minister of MoEYS, has shown his strong leadership to reform the curriculum and textbooks, the Grade 12 examination, and teacher education. Furthermore, reflecting the Cambodian Industrial Development Policy that aims to transform its industrial structure from labor-intensive industry to skill-based industry by 2025, MoEYS has been strongly initiating the enhancement of STEM (Science, Technology, Engineering, and Mathematics) education. And the new curriculum framework from primary to upper secondary level was unveiled in December 2015, and the technical education course was integrated into upper secondary level.

Among these, the most challenging reform is to upgrade RTTCs to Teacher Education Collages (TEC) which will provide bachelor's degree through 4-year programme. If TECs will start its function in 2018 as scheduled, and if new TEC students are more strictly selected, the improvement of science and mathematics education will be accelerated so that it serves for the achievement of IDP 2015-2025. In this setting, educational resources developed by the series of STEPSAMs can be proactively utilized. Outstanding TTC trainers will be TEC lecturers, the inquiry-based lesson plans and the Teacher's Guide will be utilized at TEC, and those qualified trainers and qualified teaching materials can make synergy effects on better education. In this process, MoEYS needs to encourage TECs to fully utilize those assets made by the series of the STEPSAMs for further improvements.

Technical cooperation on science and mathematics education by JICA has certainly changed the people involved and those people have been the "Change Agent" who changes the others. We expect that those "Change Agent" will find and increase the allies, and contribute not only to educational development, but also to economic, and finally to social development in Cambodia.

Appendices

Appendix 1: PDM1

Project Title: The Project for Educational Resource Development in Science and Mathematics at the Lower Secondary Level
Target Area: 6 provinces (Phnom Penh, Kandal, Kampong Cham, Takeo, Prey Veng, Battambang)
Target Group[21]: (Direct) 1. RTTC trainers in science and mathematics in the provinces: approx. 80 trainers
2. Teachers in science and mathematics in all lower secondary schools in the provinces: approx. 5,600 teachers
(Indirect) 1. Students in all lower secondary schools in the provinces: approx. 280,000 students
2. Trainees of RTTCs in the provinces: approx. 1,000 trainees
Project Period: April 2013 – March 2016

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
SUPER GOAL Student achievement in science and mathematics at the lower secondary level is improved.	Student achievement in standard curriculum on Grade 9 mathematics increased from 32% in SY2009-2010 to 70% in SY 2013-2014.[22]	Education Strategic Plan	
OVERALL GOAL The educational resources developed by the Project are disseminated to other areas through training programmes conducted by MoEYS.	1. Status of the use of developed Teacher's Guide 2. Performance of training programmes implemented by RTTC trainers	-Report/related documents of training programmes (TTD, DCD etc.) -Interview with those involved in the training	
PROJECT PURPOSE Foundation for MoEYS to support teachers for science and mathematics lesson improvement at the lower secondary level is strengthened.	3. Teacher's Guide for science and mathematics lesson improvement at the lower secondary level is approved by MoEYS. 4. In-service training contents to introduce Teacher's Guide to	1. MoEYS document 2. MoEYS document	-Teacher policy is not drastically changed. -Curriculum/textbooks in lower secondary education is not drastically changed.

21 Number of target group is based on the result of Project Formulation Study.
22 There are no indicators about science learning achievement in Education Strategic Plan 2009-2013.

	lower secondary science and mathematics teachers is approved by MoEYS.		
OUTPUTS 1. Teacher's Guide for science and mathematics lesson improvement at the lower secondary level is developed.	1. Developed Teacher's Guide[23] 2. Improvement of student achievement at the cooperative schools for chapters where Teacher's Guide covers (From X% to Y%)	1. Teacher's Guide in 5 subjects (physics, chemistry, biology, earth science and mathematics) 2. (To be determined after the Project starts)	The rate of turnover of RTTC trainers is not worsened.
2. The capacity of RTTC trainers for science and mathematics lesson improvement at the lower secondary level is enhanced.	2-1 Evaluation of RTTC trainers on in-service training 2-2 Attitude changes for lesson improvement of in-service training programmes	2-1 Observation sheets developed by the Project 2-2 Result of questionnaire for participants in in-service training programmes	
ACTIVITIES 0-1 Baseline survey is conducted. 0-2 End-line survey is conducted. **[For Output 1]** 1-1 The plan to develop Teacher's Guide is prepared. 1-2 Working groups for Teacher's Guide development are organized subject-wise. 1-3 The first drafts of Teacher's Guide are prepared. 1-4 The second drafts of Teacher's Guide are developed through workshops of the working groups. 1-5 Teacher's Guide is utilized in the schools in the target provinces on a trial basis.	**INPUTS** **CAMBODIAN SIDE** 1. Project Coordinator (TTD staff), members of working groups for Teacher's Guide development 2. Office and facilities for the Project 3. Cost for electricity and water for office **JAPANESE SIDE** 1. Dispatch of Experts 2. Provision of Equipment (office equipment, etc.) 3. Training in Japan/the third country (as necessary) 4. Cost for workshops and in-service training		

[23] Chapters for Teacher's Guide will be selected from Grade 7 to 9 textbooks in reference to RTTC curriculum.

1-6 The impact of Teacher's Guide on student achievement is measured at the cooperative schools in the target provinces. 1-7 Teacher's Guide is revised by the working groups in reflection of the comments and suggestions of school teachers. 1-8 The way and degree of using Teacher's Guide are monitored at the time of in-service training. 1-9 Activities to encourage more teachers to use Teacher's Guide are conducted. 1-10 Teacher's Guide is finalized based on the experience in the schools.	5. Other necessary expenses	
[For Output2] 2-1 An in-service training plan to introduce Teacher's Guide to lower secondary science and mathematics teachers in the target provinces is formulated. 2-2 Workshops for the preparation of in-service training are conducted at the time of Activity 1-4. 2-3 In-service training programmes to introduce Teacher's Guide are implemented for lower secondary science and mathematics teachers in the target provinces.		**PRE-CONDITIONS** -MoEYS strategy for curriculum, textbook and teacher education is not drastically changed. -Other programs do not adversely affect RTTC trainers 'participation in the Project activities.

Appendix 2: PDM2

Project Title: The Project for Educational Resource Development in Science and Mathematics at the Lower Secondary Level
Target Area: 6 provinces (Phnom Penh, Kandal, Kampong Cham, Takeo, Prey Veng, Battambang)
Target Group: (Direct) 1. RTTC trainers in science and mathematics in the provinces: approx. 80 trainers
2. Teachers in science and mathematics in all lower secondary schools in the provinces: approx. 5,600 teachers
(Indirect) 1. Students in all lower secondary schools in the provinces: approx. 280,000 students
2. Trainees of RTTCs in the provinces: approx. 1,000 trainees
Project Period: April 2013 – May 2016

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS OF VERIFICATION	IMPORTANT ASSUMPTIONS
SUPER GOAL Student achievement in science and mathematics at the lower secondary level is improved.	Student achievement in standard curriculum on Grade 9 mathematics and science	Education Strategic Plan	
OVERALL GOAL The educational resources developed by the Project are disseminated to other areas through training programmes conducted by MoEYS.	3. Status of the use of developed Teacher's Guide 4. Performance of training programmes implemented by RTTC trainers	- Report/related documents of training programmes (TTD, DCD etc.) - Interview with those involved in the training	
PROJECT PURPOSE Foundation for MoEYS to support teachers for science and mathematics lesson improvement at the lower secondary level is strengthened.	5. Teacher's Guide for science and mathematics lesson improvement at the lower secondary level is approved by MoEYS. 6. In-service training contents to introduce Teacher's Guide to lower secondary science and mathematics teachers is approved by MoEYS.	3. MoEYS document 4. MoEYS document	-Teacher policy is not drastically changed. -Curriculum/textbooks in lower secondary education is not drastically changed.

OUTPUTS 3. Teacher's Guide for science and mathematics lesson improvement at the lower secondary level is developed.	1-1. Developed Teacher's Guide[24] 1-2. Improvement in teaching at the cooperative schools for chapters where Teacher's Guide covers: • More than 60% of teachers show positive changes in more than 60% of viewpoints.	1-1. Teacher's Guide in 5 subjects (physics, chemistry, biology, earth science and mathematics) 1-2. End line survey results and other monitoring results	The rate of turnover of RTTC trainers is not worsened.
4. The capacity of RTTC trainers for science and mathematics lesson improvement at the lower secondary level is enhanced.	2-1. Evaluation of RTTC trainers on in-service training 2-2. Changes in participants' attitude toward lesson improvement through in-service training programmes	2-1. Capacity Development check-list and Observation sheet developed by the project 2-2. Result of questionnaire for participants in in-service training programmes	
ACTIVITIES 0-1 Baseline survey is conducted. 0-2 End-line survey is conducted. **[For Output 1]** 1-11 The plan to develop Teacher's Guide is prepared.	**INPUTS** **CAMBODIAN SIDE** 3. Project Coordinator (TTD staff), members of working groups for Teacher's Guide development 4. Office and facilities for the Project		

[24] Chapters for Teacher's Guide will be selected from Grade 7 to 9 textbooks in reference to RTTC curriculum.

1-12 Working groups for Teacher's Guide development are organized subject-wise. 1-13 The first drafts of Teacher's Guide are prepared. 1-14 The second drafts of Teacher's Guide are developed through workshops of the working groups. 1-15 Teacher's Guide is utilized in the schools on a trial basis. 1-16 Changes in the ways of teaching are monitored. 1-17 The students' level of understanding is monitored. 1-18 Teacher's Guide is revised by the working groups in reflection of the comments and suggestions of school teachers. 1-19 The way and degree of using Teacher's Guide are monitored at the time of in-service training. 1-20 Activities to encourage more teachers to use Teacher's Guide are conducted. 1-21 Teacher's Guide is finalized based on the experience in the schools.	4. Cost for electricity and water for office **<u>JAPANESE SIDE</u>** 6. Dispatch of Experts 7. Provision of Equipment (office equipment, etc.) 8. Training in Japan/the third country (as necessary) 9. Cost for workshops and in-service training 10. Other necessary expenses	
[For Output2] 2-4 An in-service training plan to introduce Teacher's Guide to lower secondary science and mathematics teachers in the target provinces is formulated. 2-5 Workshops for the preparation of in-service training are conducted at the time of Activity 1-4. 2-6 In-service training programmes to introduce Teacher's Guide are implemented for lower secondary science and mathematics teachers in the target provinces.		**<u>PRE-CONDITIONS</u>** - MoEYS strategy for curriculum, textbook and teacher education is not drastically changed. - Other programs do not adversely affect RTTC trainers 'participation in the Project activities.

Appendix 3: Test questions for INSET participants
Biology

Cells of Plants （Grade 7, Chapter 3 Lesson 3)

1. Choose only one option that you think most appropriate in teaching the cells of plants.

(a) In teaching structure of plant cell, the teacher lets students memorize the name of structure of plant cell on the textbook.

(b) In teaching structure of plant cell, the teacher lets students explain the name of structure of plant cell by the words only on the textbook.

(c) In teaching structure of plant cell, the teacher lets students explain the name of structure of plant cell by the figure on the textbook.

(d) In teaching structure of plant cell, the teacher lets students explain the structure of plant cell through drawing plant cell.

Cell Respiration （Grade 8, Chapter 4 Lesson 3)

2. Choose only one option that you think most appropriate in teaching the cell respiration.

(a) In teaching the pathway of cell respiration, the teacher lets students memorize the name of the pathway of cell respiration on the textbook.

(b) In teaching the pathway of cell respiration, the teacher lets students explain the name of the pathway of cell respiration by the words only on the textbook.

(c) In teaching the pathway of cell respiration, the teacher lets students explain the pathway of cell respiration through the activity "What is a product of respiration?"

(d) In teaching the pathway of cell respiration, the teacher lets students explain the pathway of cell respiration by the figure on the textbook.

Transport System （Grade 8, Chapter 4 Lesson 4)

3. Choose only one option that you think most appropriate in teaching the heart.

(a) In teaching structure of heart, the teacher lets students memorize the name of structure of heart on the textbook.

(b) In teaching structure of heart, the teacher lets students explain the structure of heart through drawing heart.

(c) In teaching structure of heart, the teacher lets students explain the name of structure of heart by the figure on the textbook.

(d) In teaching structure of heart, the teacher lets students explain the name of structure of heart by the words only on the textbook.

Appendix 3: Test questions for INSET participants
Biology

Peripheral Nervous System （Grade 9, Chapter 2 Lesson 3)

4. Choose only one option that you think most appropriate in teaching the reflex.

(a) In teaching reflex, the teacher lets students explain the reflex through activity of knee - jerk reflex.

(b) In teaching reflex, the teacher lets students memorize the name of pathway of reflex on the textbook.

(c) In teaching reflex, the teacher lets students explain the reflex by the figure on the textbook.

(d) In teaching reflex, the teacher lets students explain the name of pathway of reflex by the words only on the textbook.

Immune System （Grade 9, Chapter 3 Lesson 2)

5. A chemical that kills bacteria or slow their growth without harming body cells is called a(an) (　　).

(a) macrophage (b) antibiotics (c) antigen (d) pathogen

Appendix 3: Test questions for INSET participants
Biology

Answer

1. (d) In teaching structure of plant cell, the teacher lets students explain the structure of plant cell through drawing plant cell.
2. (c) In teaching the pathway of cell respiration, the teacher lets students explain the pathway of cell respiration through the activity "What is a product of respiration?"
3. (b) In teaching structure of heart, the teacher lets students explain the structure of heart through drawing heart.
4. (a) In teaching reflex, the teacher lets students explain the reflex through activity of knee - jerk reflex.
5. (b) antibiotics

each 10 points - 50

Appendix 3: Test questions for INSET participants
Chemistry

Chem_G7_Ch2_L2_(Factors_of_Phase_Change_of_a_Substance)

1. Choose the most appropriate activity from the following activities (a)-(d) in this content "Factors of phase change of a substance".
   (a) Students discuss to classify the examples of physical changes and chemical changes.
   (b) Teacher demonstrates experiments on typical physical changes and chemical changes to students and gives their definitions to students.
   (c) Students conducts a few experiments on typical physical changes and chemical changes, and discuss on the characteristics of phase changes and chemical changes.
   (d) Teacher gives the chapter-end problems on physical changes and chemical changes and students try to prepare examinations

Chem_G8_Ch2_L1_(Mixture)

2. Choose the most appropriate activity from the following activities (a)-(d) in this content "Mixture".
   (a) Teacher shows several particle models of pure substances (element, compound), mixtures (homogeneous and heterogeneous) for students to discuss and gives clear definitions of them to students.
   (b) Students discuss on the characteristics of pure substances (element or compound) and mixtures and make a few particle models for pure substances and hetero- and homogeneous mixtures.
   (c) At first, teacher gives clear definitions of pure substances and mixtures, and explain the characteristics of them.
   (d) Students try to solve the chapter-end problems related to this content.

Chem_G8_Ch2_L2_(Mixture Separation)

3. Choose the most appropriate activity from the following activities (a)-(d) in this content "Mixture Separation".
   (a) Students conduct a few experiments on separation and purification and explain the separation and purification methods for the different purposes.
   (b) Teacher explains the filtration, distillation, and crystallization apparatuses and demonstrates the procedures.
   (c) Students read the textbook on the separation methods and understand the meanings of the separation methods.
   (d) Teacher gives the chapter-end problems of the textbook on this content to

students, and students try to solve them.

Chem_G9_Ch2_L1_(Carbon)

4. Choose the most appropriate activity from the following activities (a)-(d) in this content "Carbon".
   (a) Students explain the roles of carbon in chemical reactions, and properties of carbonates compounds (calcium carbonate, quicklime and slaked lime).
   (b) Teacher demonstrates a few experiments on the roles of carbon in chemical reactions, and properties of carbonates.
   (c) Students conduct a few experiments on reduction of copper(II) oxide with charcoal, heat decomposition of copper(II) carbonate, and heat decomposition of calcium carbonate. Students explain the experimental observations.
   (d) Students try to solve the questions and exercises to prepare examination.

Chem_G9_Ch2_L2_(Oxygen)

5. Choose the correct combination of words in the following sentence.
   A flame of a candle is composed three parts: the most inner is a flame core, where is occurred ( ) combustion and mainly ( ) gas, the second is a inner flame, where is occurred ( ) combustion and remaining ( ) is heated to make brightest light, and the third is an outer flame, where is occurred ( ) combustion and the flame is almost transparent.
   (a) Incomplete, hydrogen, complete, carbon, complete
   (b) Complete, paraffin, complete, carbon, incomplete
   (c) Incomplete, praffine, incomplete, carbon, complete
   (d) Complete, carbon, incomplete, hydrogen, incomplete

Appendix 3: Test questions for INSET participants
Chemistry

Answers

1. (c) is the best, 10 points,
   (a) is better, 5 points,
   (b) and (d) are 0 point
2. (b) is the best, 10 points.
   (a) and (c) are 5 points.
   (c) Is 0 points.
3. (a) is the best, 10 points,
   (b) Is better, 5 points,
   (c) and (d) are 0 points.
4. (c) is the best, 10 points,
   (a) and (b) are 5 points,
   (d) is 0 points.
5. (c) is 10 points.

Appendix 3: Test questions for INSET participants
Earth Science

Rotating Motion of the Earth （Grade 7, Chapter 2 Lesson 1）

1. Choose only one option that you think most appropriate in teaching the rotating motion of the Earth.

(a) In teaching rotating motion of the Earth, the teacher lets students memorize the name of rotation and revolution on the textbook.

(b) In teaching rotating motion of the Earth, the teacher lets students explain the name of rotation and revolution by the words only on the textbook.

(c) In teaching rotating motion of the Earth, the teacher lets students explain the name of rotation and revolution by the figure on the textbook.

(d) In teaching rotating motion of the Earth, the teacher lets students explain the rotation and revolution through drawing models of sun and earth.

Earth's Characteristics （Grade 8, Chapter 1 Lesson 1）

2. Choose only one option that you think most appropriate in teaching the Earth's interior.

(a) In teaching Earth's interior, the teacher lets students memorize the name of parts such as crust, mantle and core on the textbook.

(b) In teaching Earth's interior, the teacher lets students explain the name of parts such as crust, mantle and core by the words only on the textbook.

(c) In teaching Earth's interior, the teacher lets students explain the parts such as crust, mantle and core through the activity "Let's study the inside of earth by reading the graph of the speed of seismic waves?"

(d) In teaching Earth's interior, the teacher lets students explain the parts such as crust, mantle and core by the figure on the textbook.

Earthquake （Grade 9, Chapter 2 Lesson 4）

3. Choose only one option that you think most appropriate in teaching the Earthquake.

(a) In teaching structure of heart, the teacher lets students memorize the name of seismic waves such as P wave and S wave on the textbook.

(b) In teaching structure of heart, the teacher lets students explain the seismic waves such as P wave and S wave through the activity "Let's make P wave and S wave?".

(c) In teaching structure of heart, the teacher lets students explain the name of seismic waves such as P wave and S wave by the figure on the textbook.

(d) In teaching structure of heart, the teacher lets students explain the name of

seismic waves such as P wave and S wave by the words only on the textbook.

Mineral and Fossil Fuel (Grade 9, Chapter 2 Lesson 5)

4. Choose only one option that you think most appropriate in teaching mineral and fossil fuel.

(a) In teaching mineral and fossil fuel, the teacher lets students explain impact of fossil fuel to environment such as acid rain through reading column of 'Dealing with fossil fuel problem'.

(b) In teaching mineral and fossil fuel, the teacher lets students memorize the name of impact of fossil fuel to environment such as acid rain on the textbook.

(c) In teaching mineral and fossil fuel, the teacher lets students explain impact of fossil fuel to environment such as acid rain by the passage on the textbook.

(d) In teaching mineral and fossil fuel, the teacher lets students explain the name of impact of fossil fuel to environment such as acid rain on the textbook.

Answer (each 10 points -40)

(1) d

(2) c

(3) b

(4) a

Appendix 3: Test questions for INSET participants
Physics

Electrical Voltage (Grade7, Chapter3, Lesson3)

1. Choose only one option that you think most appropriate in teaching Electrical Voltage.

(a) In teaching Electrical Voltage, the teacher lets students memorize the pictures of electrical circuit such as switch, battery, light bulb, voltmeter etc. on the textbook.

(b) In teaching Electrical Voltage, the teacher lets students do solve questionnaires as many as possible.

(c) In teaching Electrical Voltage, the teacher explains the difference between batteries in series and parallel by drawing the structure.

(d) In teaching Electrical Voltage, the teacher lets students find definition of voltage through experiment.

Electrical Resistance (Grade7, Chapter3, Lesson4)

2. Choose only one option that you think most appropriate in teaching Electrical Resistance.

(a) In teaching Electrical Resistance, the teacher lets students memorize a formula of $R=\rho(1/A)$.

(b) In teaching Electrical Resistance, the teacher lets students read the textbook twice.

(c) In teaching Electrical Resistance, the teacher lets students conduct any activity which relates to this lesson by group.

(d) In teaching Electrical Resistance, the teacher lets students understand the change of electrical resistance depended on length, surface area.

Work and Energy (Grade8, Chapter3, Lesson1)

3. Choose only one option that you think most appropriate in teaching Work and Energy.

(a) In teaching Work and Energy, the teacher lets students memorize the related technical words one by one on the textbook.

(b) In teaching Work and Energy, the teacher lets students memorize a formula $W=F \times d$.

(c) In teaching Work and Energy, the teacher lets students explain the meaning of a formula $W=F \times d$ with some examples.

(d) In teaching Work and Energy, the teacher lets students divide into 4 groups to solve questionnaires on textbook.

Power (Grade8, Chapter3, Lesson2)

4. Choose only one option that you think most appropriate in teaching Power.

(a) In teaching Power, the teacher lets students explain the meaning of a formula

Power = (Work/Time) with some examples.

(b) In teaching Power, the teacher lets students memorize the name of experiment materials on the textbook.

(c) In teaching Power, the teacher lets students memorize all the sentences on the textbook.

(d) In teaching Power, the teacher makes students raise their hands a lot of times to answer questions that the teacher asks because it is a student centered learning style.

Electromagnetic Force (Grade9, Chapter4, Lesson3)

5. Choose the most appropriate experiment to find relationship between direction of magnetic field, direction of electric current and direction of force on a conductor.

(a) Change direction of magnetic field and direction of electric current one by one, then record direction of movement (force).

(b) We do not need to check their directions, because they are always constant in any situation.

(c) We cannot find any relationship among them, because there is no relationship among them.

(d) Find the direction of electric current, then we can define the direction of magnetic field and direction of force on a conductor.

Electromagnetic Induction (Grade9, Chapter4, Lesson4)

6. Choose one the most appropriate method to make electric current greater in electromagnetic induction.

(a) 200 times of turns in a coil is the most suitable to make the greatest electric current.

(b) Bigger size of magnet is better to generate greater electric current.

(c) Magnet or coil moving slower is necessary to generate greater electric current.

(d) Greater number of turns in a coil is better to generate greater electric current.

Appendix 3: Test questions for INSET participants
Physics

Answer

Answer (10 points each, total 50 points)

1. (c)
2. (d)
3. (c)
4. (a)
5. (a)
6. (d)

Appendix 3: Test questions for INSET participants
Mathematics

The Project for Educational Resource Development
in Science and Mathematics at the Lower Secondary Level

Mathematics **Questions for Evaluation** STEPSAM

Handout 8-2

Name of your school:

Your name:

Date: DD/MM/2015

Grade 7 **Parallel lines, parpendicular lines (Lesson 14)**

Question		Please circle one of the options.
1 On the textbook, there is a question to show that if two lines d1 and d2 are parallel and the third line d3 is parallel to d1, then d3 is also parallel to the second line d2. About the instruction about this question, select one option from the right that you think is most appropriate fof Grade 7 student d1 _____ d2 _____ d3 _____	**A**	The teacher deals with it as a "mathematical fact" without proof.
	B	The teahcer proves it in the way that: we know d1||d2 and d1||d3, therefore d2||d3.
	C	The teacher skips this question.
	D	The teacher proves it by showing that: if d2 is not parallel to d3, then there will be a contradiction.

Grade 7 **Two dimensional geometric shapes (Lesson 15)**

Question		Please circle one of the options.
2 Among A, B, C and D on the right, choose one option that you think is the most appropriate way to teach the properties of rectangles to Grade 7 students.	**A**	The teacher and students together read aloud the properties of rectangles to facilitate memorisation.
	B	The teacher theoretically explains the properties of rectangles.
	C	The teacher has students fold and cut rectangle-shape papers to find the properties of rectangles.
	D	The teacher gives students sufficient time to individually consider why these properties hold.

Grade 8 **Proportion and percent (Lesson 3)**

Question		Please circle one of the options.
3 Among A, B, C and D on the right, choose one option that you think is the most appropriate way to teach the proportional relationship y = ax to Grade 7 students.	**A**	The teacher uses abstract expression and explains theoretically as in the textbook.
	B	The teacher introduces it through concrete examples and uses a table to show the relationship between x and y.
	C	The teacher gives students sufficient time to memorise the relationship y = ax.
	D	The teacher has students work in group to discuss the meaning of the relationship y = ax.

Appendix 3: Test questions for INSET participants
Mathematics

Grade 8 **Lines and Special Segments Intersecting in a Triangle (Lesson 16)**

Question		Please circle one of the options.
4 Among the options A, B, C and D, choose one option that you think is TRUE about centroid, circumcenter, orthocenter and incenter in a right-angle triangle.	**A**	The centroid of a right-angle triangle does not exist.
	B	The orthocenter of a right-angle triangle is a vertex of the triangle.
	C	The circumcenter of a right-angle triangle is outside the triangle.
	D	The incenter of a right-angle triangle is on a side of the triangle.

Grade 9 **Statistical Mean (Lesson 7)**

Question		Please circle one of the options.
5 Suppose that we have data of the number of children of five families: 2 4 1 3 4. Among the options A, B, C and D, choose one option that you think is the most appropriate description of the mean value of the data.	**A**	The mean value of the data is calculated as 2.8, but it is not real mean because the number of children must be an integer.
	B	The mean value of the data is 2.8 and it contains all the information of the data.
	C	The mean value of the data is 2.8. But we should use the mode=4 instead of the mean value, since the number of children must be an integer.
	D	The mean value of the data is 2.8 and it represents some tendency of the data as a whole.

Grade 9 **Circles and Lines (Lesson 13)**

Question		Please circle one of the options.
6 Among the options A, B, C and D, choose one option that you think is the most appropriate way to teach that a tangent line of a circle is perpendicular to the radius.	**A**	The teacher writes the sentence “A tangent line is perpendicular to the radius” on the blackboard and let students read and repeat until they fully memorize the fact.
	B	The teacher lets students read the textbook and wait until all the students say that they understand the proposition.
	C	The teacher draws or has students draw the figure of a circle and a chord and has students think what happens as the chord moves to the edge of the circle.
	D	The teacher lets students solve the problems of tangent lines without teaching the fact that a tangent line is perpendicular to the radius.

Appendix 4 Test questions for RTTC trainers' understanding check Biology

Grade 7	**Questionnaire** (Check ☑ in Yes or No)	STEPSAM

Plants with flower (2-2)			
1	Among A, B, C and D on the right, please choose only one option that you think most appropriate in teaching the structure of flower in Grade 7.	**A**	In teaching the structure of flower, the teacher lets students explain the name of the organ by the words only.
		B	In teaching the structure of flower, the teacher let students explain the name of the organ by the figure of the textbook.
		C	In teaching the structure of flower, the teacher lets students explain the name of the organ through the observation of the flower.
		D	In teaching the structure of flower, the teacher lets students memorize the name of the organ in the flower on the textbook.

Structure of cells (3-1)			
Question		**Please circle one of the options.**	
2	Among A, B, C and D on the right, please choose only one option that you think most appropriate in teaching the structure of cells in Grade 7.	**A**	In teaching structure of cells, the teacher lets students explain the common points and different points between animal cell and plant cell by the figure on the textbook.
		B	In teaching structure of cells, the teacher lets students explain the common points and different points between animal cell and plant cell through observation of cells.
		C	In teaching structure of cells, the teacher lets students memorize the name of structure of plant and animal cells on the textbook.
		D	In teaching structure of cells, the teacher lets students explain the common points and different points between animal cell and plant cell by the words only on the textbook.

Components of the digestive system (4-2)			
Question		**Please circle one of the options.**	
3	Among A, B, C and D on the right, please choose only one option that you think most appropriate in teaching the digestion of human in Grade 7.	**A**	In teaching digestion, the teacher lets students explain the organ name and function in the digestive system by using the figure of the textbook.
		B	In teaching digestion, the teacher lets students memorize the organ name in the digestive system on the textbook.
		C	In teaching digestion, the teacher lets students explain the organ name in the digestive system by the words only.
		D	In teaching digestion, the teacher let students explain the organ name in the digestive system by using the figure of the textbook.

Tobacco and cigarettes (5-2)			
Question		**Please circle one of the options.**	
4	Among A, B, C and D on the right, please choose only one option that shows the symptom of chronic bronchitis in the tabacco and cigarettes in Grade 7.	**A**	People do not get enough oxygen and cannot adequately eliminate carbon dioxide.
		B	Tumors take away space in the lung that is used for gas exchange.
		C	People have difficulty breathing. It can cause permanent damage to the breathing passage.
		D	It is often characterized as including inflammation of the parenchyma of the lung and abnormal alveoli filling with fluid.

Appendix 4 Test questions for RTTC trainers' understanding check Biology

Grade 8

Questionnaire

(Check ☑ in Yes or No)

Food relationships in the environment (2-2)			
Question		**Please circle one of the options.**	
1	Among A, B, C and D on the right, please choose only one option that you think most appropriate in teaching the food relationships in the environment in Grade 8.	**A**	In teaching the food web, the teacher lets students memorize the definition of food web on the textbook.
		B	In teaching the food web, the teacher lets students explain the relationship between food chain and food web on the textbook by only words.
		C	In teaching the food web, the teacher lets students explain the food web by the figure on the textbook.
		D	In teaching the food web, the teacher lets students explain the food web by the various examples by the figure on textbook and TG.

Transport in vascular plants (3-2)			
Question		**Please circle one of the options.**	
2	Among A, B, C and D on the right, please choose only one option that you think most appropriate in teaching the transport in vascular plants in Grade 8.	**A**	In teaching the transpiration, the teacher lets students memorize the transpiration as the word on the textbook.
		B	In teaching the transpiration, the teacher lets students memorize the definition of the transpiration on the textbook.
		C	In teaching the transpiration, the teacher lets students explain the transpiration by the figure on the textbook.
		D	In teaching the transpiration, the teacher lets students explain the transpiration through the experiment of transpiration.

Diet and energy(5-2)			
Question		**Please circle one of the options.**	
3	Among A, B, C and D on the right, please choose only one option that you think most appropriate in teaching the diet and the energy in Grade 8.	**A**	In teaching the diet and energy, the teacher lets students explain the relationship between food and nutrition by the textbook.
		B	In teaching the diet and energy, the teacher lets students explain the relationship between food and nutrition through the experiment “Which foods contain starch?”.
		C	In teaching the diet and energy, the teacher lets students memorize the kinds of nutrition on the textbook.
		D	In teaching the diet and energy, the teacher lets students explain the kinds of nutrition on the textbook.

Drugs (6-1)			
Question		**Please circle one of the options.**	
4	Among A, B, C and D on the right, please choose only one option that shows the function of drugs in the drugs in Grade 8.	**A**	A drug disrupts the functioning of the nervous system.
		B	A drug destroys the digestive system.
		C	A drug destroys the muscular system.
		D	A drug disrupts the functioning of the skeletal system.

Appendix 4 Test questions for RTTC trainers' understanding check Biology

Grade 9

Questionnaire

(Check ☑ in Yes or No)

Photosynthetic process(1-2)

Question		Please circle one of the options.	
1	Among A, B, C and D on the right, please choose only one option that you think most appropriate in teaching the photosynthetic process in Grade 9.	**A**	In teaching the photosynthesis, the teacher lets students explain the photosynthesis by the figure on the textbook.
		B	In teaching the photosynthesis, the teacher lets students explain the photosynthesis through the experiment that shows to contain starch in the potato.
		C	In teaching the photosynthesis, the teacher lets students memorize the photosynthesis as the word on the textbook.
		D	In teaching the photosynthesis, the teacher lets students memorize the photosynthetic process on the textbook.

Central nervous system (2-2)

Question		Please circle one of the options.	
2	Among A, B, C and D on the right, please choose only one option that you think most appropriate in teaching the central nervous system in Grade 9.	**A**	In teaching the central nervous system, the teacher lets students explain the structure of the brain through the observation of chicken head.
		B	In teaching the central nervous system, the teacher lets students memorize the structure of the brain on the textbook.
		C	In teaching the central nervous system, the teacher lets students explain the structure of the brain on the textbook.
		D	In teaching the central nervous system, the teacher lets students explain the structure of the brain by the figure on the textbook.

Body defence (3-1)			
Question		**Please circle one of the options.**	
3	Among A, B, C and D on the right, please choose only one option that shows the function of white blood cells in the body defense in Grade 9	**A**	It produces antibody.
		B	It engulfs the pathogens.
		C	It releases a strong acid.
		D	It traps and removes the pathogens.

Infectious agents (4-1)			
Question		**Please circle one of the options.**	
4	Among A, B, C and D on the right, please choose only one option that shows the correct answer to the question in the infectious agent in Grade 9. “Suppose a bacterium reproduces by binary fission every 20 minutes. How many cells are there after 2 hours?”	**A**	4 cells.
		B	16 cells.
		C	32 cells.
		D	64 cells.

Appendix 4 Test questions for RTTC trainers' understanding check Chemistry

Chemistry
Grade 7

Questionnaire
(Check ☑ in Yes or No)

Name of your school

Your name

Date
DD/MM/2015

Teaching "Substance" (Lesson 1)

Question		Please circle one of the options.	
1	Choose the most effective activity from the following activities A-D in this chapter "substances and their classification".	A	Teacher explains to students the states of substances, characteristics of substances, and characterization by using the density of substance.
		B	Students learn the textbook and the questions and exercises to explain three states, characteristics of substances, density calculation, and classification of substances.
		C	Teacher demonstrates several items of substances to students to identify their states and to classify the substances, and conducts a few experiments for students to understand.
		D	Teacher helps that students have clear objectives of this chapter and students conducts a few experiments to confirm characteristics of three states, density calculation, and classification of substances.

Teaching "Phase change of substance" (Lesson 2)

Question		Please circle one of the options	
2	Under normal pressure and around room temperature (0℃ - 40℃), which substances of the following list are able to be a phase change of sublimation? Choose the most correct combination from A-D. [mercury, iron, oxygen, water, dry ice (carbon dioxide (solid)), ice (water (solid)), diamond, iodine]	A	mercury, iron, diamond
		B	water, oxygen, iodine
		C	dry ice(carbon dioxide(solid)), ice (water(solid)), iodine
		D	mercury, ice, iodine

Teaching "The air" (Lesson 1)

Question		Please circle one of the options	
3	Choose the most effective activity from the following activities A-D in this chapter “air”.	A	In this chapter " air" and "air pollution", teacher explains that the air components are nitrogen, carbon dioxide, and their properties and also explains the causes of air pollution.
		B	In this chapter " air" and "air pollution", students discuss on the air components and the methods to identify the gases and conduct a few experiments for the identifications of gases.
		C	In this chapter " air" and "air pollution", students summarize the air components and the methods to identify the gases and solve questions and exercises at the chapter-end.
		D	In this chapter " air" and "air pollution", teacher checks the students' understandings on the topics and explains their wrong or less knowledge on the air to be correct ones.

Appendix 4 Test questions for RTTC trainers' understanding check Chemistry

Chemistry
Grade 8

Questionnaire
(Check ☑ in Yes or No)

Name of your school

Your name

Date
DD/MM/2015

Teaching "Atom and Molecules" (Lesson 1)

Question		Please circle one of the options.	
1	In this chapter "Atoms and Molecular Theories", choose the most effective sequence of activities from A-D activities.	A	1) Teacher teaches the history of the discovery of atom and molecule. 2) Students memorize the chemical symbols and chemical formula. 3) Teacher explains the definitions of elements and compounds.
		B	1) Teacher supports that students use paper models of atoms to make elements and molecules. 2) Teacher helps that students write chemical formula and chemical reaction formula by using chemical symbols and models. 3) Students discuss what are elements and what are pure substances, what are compounds.
		C	1) Teacher shows the real daily use materials like iron, aluminum, water, charcoal, etc. and their chemical formula. 2) Students understand the chemical symbols and chemical formula of the real substances . 3) Teacher explains the definitions of elements and compounds.
		D	1) Students investigate the definitions of atom and molecule, chemical symbol, chemical formula, elements, and compounds. 2) Teacher gives questions and exercises on this chapter for students to solve and prepare the examination.

Teaching "Solution" (Lesson 3)

Question		Please circle one of the options.	
2	Choose the most appropriate concentration of salt solution. We dissolve 15 g of salt in 45 g of water.	A	45%
		B	30%
		C	25%
		D	15%

Appendix 4 Test questions for RTTC trainers' understanding check Chemistry

Chemistry
Grade 9

Questionnaire
(Check ☑ in Yes or No)

Name of your school

Your name

Date
DD/MM/2015

Teaching "The Periodic Table of Elements" (Lesson 1)			
Question		Please circle one of the options	
1	Choose the most effective teaching approach for this chapter "Periodic Tables and Elements" from A-D approaches.	A	Teacher asks students to make a periodic table on their notebook or desk, and teacher discusses with students on the criteria of the arrangement of elements and meanings of the group numbers.
		B	Teacher explains a periodic table of the textbook or on blackboard, and teacher explains the criteria of the arrangement of elements and meanings of the group numbers.
		C	Teacher tells a story on Mendeleyev to students and explain the structure and meanings of the periodic table. The groups of the periodic table is also explained by teacher.
		D	Teacher delivers a periodic table to each students and asks students to memorize the order of the elements.

Teaching "Oxide" (Lesson 1)			
Question		Please circle one of the options.	
2	Choose the most effective activity from the following activities A-D in this chapter “Oxide, Acid, Base, and Salt”.	A	This chapter involves many chemical reactions so that main activities for students are memorizations of keywords and chemical reactions.
		B	Teacher summarizes important oxides, acids, bases, and salts and their properties as tables to students and students memorize them.
		C	Teacher demonstrates a few experiments on the representative chemical reactions in this chapter and teacher discusses the experimental results with students to understand concepts of oxide, acid, base, and salt.
		D	Teacher supports students to understand the relationships among oxide, acid, base, and salt and to conduct a few experiments on the representative chemical reactions for this chapter.

Appendix 4 Test questions for RTTC trainers' understanding check Earth Science

Grade 7

Questionnaire
(Check ☑ in Yes or No)

Name of your school _____

Your name _____

Date

Teaching "Formation of the Solar System" (Lesson 1)

Question		Please circle one of the options.
1 Among A, B, C and D on the right, please choose only one option that you think most appropriate in teaching the formation of solar system in Grade 7.	A	In teaching the formation of solar system, the teacher lets students explain the name of the planets by the words only.
	B	In teaching the formation of solar system, the teacher let students explain the name of the planets by the figure of the textbook.
	C	In teaching the formation of solar system, the teacher lets students explain the name of the planets through the activity of the revolution and rotation.
	D	In teaching the formation of solar system, the teacher lets students memorize the name of the planets on the textbook.

Teaching "The Seasons on the Earth" (Lesson 2)			
Question		**Please circle one of the options.**	
2	Among A, B, C and D on the right, please choose only one option that you think most appropriate in teaching the season on the earth in Grade 7.	A	In teaching season, the teacher lets students explain the name of season by using the figure of the textbook.
		B	In teaching sun, the teacher lets students memorize the name of season on the textbook.
		C	In teaching season, the teacher lets students explain the name of season by the words only.
		D	In teaching season, the teacher let students explain the name of season by using the model sun and model earth.

Appendix 4 Test questions for RTTC trainers' understanding check Earth Science

Grade 8

Questionnaire
(Check ☑ in Yes or No)

Name of your school

Your name

Date

Teaching "The Earth's Atmosphere" (Lesson 2)

Question		Please circle one of the options.	
1	Among A, B, C and D on the right, please choose only one option that you think most appropriate in teaching the earth's atmosphere in Grade 8.	A	In teaching the earth's atmosphere, the teacher lets students memorize the name of atmosperic layers on the textbook.
		B	In teaching the earth's atmosphere, the teacher lets students explain the characteristic of atmosperic layers on the textbook by only words.
		C	In teaching the earth's atmosphere, the teacher lets students explain the atmosperic layers by the figure on the textbook.
		D	In teaching the earth's atmosphere, the teacher lets students explain the atmosperic layers by reading the various topics on TG.

Teaching "The Rock Cycle" (Lesson 3)

Question		Please circle one of the options.	
2	Among A, B, C and D on the right, please choose only one option that shows the rock cycle in Grade 8.	A	A metamorphic rock becomes magma in meltiong.
		B	A magma become sedimentary rock in cooling.
		C	A metamorphic rock becomes sedimetary rock in heating or pressure.
		D	A igneous rock becomes metamorphic rock in weathering.

Teaching "Motion of the Earth and the Moon" (Lesson 1)			
Question		**Please circle one of the options.**	
3	Among A, B, C and D on the right, please choose only one option that you think most appropriate in teaching motion of the earth and moon in Grade 8.	A	In teaching the motion of the earth and moon , the teacher lets students memorize the rotation and revolution as the word on the textbook.
		B	In teaching the motion of the earth and moon, the teacher lets students memorize the definition of therotation and revolution on the textbook.
		C	In teaching the motion of the earth and moon, the teacher lets students explain the rotation and revolution by the figure on the textbook.
		D	In teaching the motion of the earth and moon, the teacher lets students explain the rotation and revolution through the experiment of model earth and model moon.

Appendix 4 Test questions for RTTC trainers' understanding check Earth Science

Grade 9

Questionnaire
(Check ☑ in Yes or No)

Name of your school _____

Your name _____

Date

Teaching "Solid Waste" (Lesson 1)

Question		Please circle one of the options.	
2	Among A, B, C and D on the right, please choose only one option that you think most appropriate in teaching the solid waste in Grade 9.	A	In teaching the solid waste, the teacher lets students explain the solid waste through activity of listing waste goods in their house.
		B	In teaching the solid waste, the teacher lets students memorize the solid waste on the textbook.
		C	In teaching the solid waste, the teacher lets students explain the solid waste on the textbook.
		D	In teaching the solid waste, the teacher lets students explain the solid waste by showing the figure on TG.

Appendix 4 Test questions for RTTC trainers' understanding check Physics

Physics
Grade 7

Questionnaire
(Check ☑ in Yes or No)

Name of your school

Your name

Date
DD/MM/2015

Teaching "Thermal Expansion of a Body" (Chapter 1-2)

Question		Please circle one of the options.
1 Among A, B, C and D on the right, please choose only one option that you think most appropriate in teaching Thermal Expansion of a Body in Grade 7.	A	The teacher asks students to memorize the coefficient of expansion of each solid material.
	B	The teacher introduce various kinds of application of thermal expansion in our daily life.
	C	The teacher does not necessary to explain thermal expansion of solid because solid do not expand at all.
	D	The teacher has to explain only stated in the textbook without experiments or activities.

Teaching "Electric Charge" (Chapter 3-1)

Question		Please circle one of the options.
2 Among A, B, C and D on the right, please choose only one option that you think most appropriate in teaching Electric Charge in Grade 7.	A	The teacher asks students to memorize types of charge with their characteristics without experiment to find them.
	B	All the teacher has to do is to read the explanation stated in the textbook.
	C	The teacher has to prepare various types of experiment especially related to static electricity based on daily life.
	D	The teacher asks students to touch electricity from socket to feel electricity.

Teaching "Solid Pressure" (Chapter 4-1)

Question		Please circle one of the options.
3 Among A, B, C and D on the right, please choose only one option that you think most appropriate in teaching Solid Pressure in Grade 7.	A	The teacher provide exercises to students as much as possible with example by using real materials.
	B	All the teacher as to do is to ask students to memorize the formula to find the solid pressure.
	C	The teacher provide enough exercise with example by using real materials.
	D	The teacher asks students to read definition of solid pressure to memorize it.

Appendix 4 Test questions for RTTC trainers' understanding check Physics

Physics
Grade 8

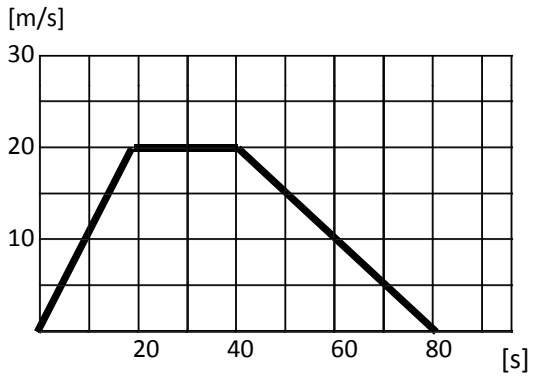
Questionnaire
(Check ☑ in Yes or No)

Name of your school

Your name

Date
DD/MM/2015

Teaching "Instantaneous Velocity and Acceleration" (Chapter 1-2)

Question	Please circle one of the options.	
All the sentences A, B, C and D on the right are explanation about the graph below showing the changes of time and velocity of a car, please choose only one option that is **NOT** correct. 1  	A	The car move with constant velocity of 20[m/s] from 20[s] to 40[s]
	B	Acceleration of the car from 0[s] to 20[s] is 1[m/s^2]
	C	Total distance of car travelled is 200[m].
	D	Acceleration of the car from 40[s] to 80[s] is 1[m/s2]

Teaching "Newton's Law" (Chapter 2-3)

Question		Please circle one of the options.
2 Among A, B, C and D on the right, please choose only one option that you think most appropriate in teaching Newton's Law in Grade 8.	A	The teacher asks students just to memorize Newton's Law.
	B	All the teacher has to do is to ask students to memorize the formula of Newton's Second Law.
	C	The teacher explain how to calculate questions related to Newton's Law without experiment or practical example.
	D	The teacher give students various kind of activity and calculation related to Newton's Law.

Teaching "Magnet" (Chapter 5-1)

Question		Please circle one of the options.
3 Among A, B, C and D on the right, please choose only one option that you think most appropriate in teaching Magnet in Grade 8.	A	The teacher only shows pictures in the textbook and explain verbally because it is very difficult to get necessary material in school.
	B	The teacher prepares necessary materials including improvised materials to implement experiments and activities to have students understand the property of magnet.
	C	The teacher asks students to read magnetic property until they memorize well.
	D	Solving exercise is more important than activity using magnet.

Teaching "Sound Receivers" (Chapter 6-2)

Question		Please circle one of the options.
4 Among A, B, C and D on the right, please choose only one option that you think most appropriate in teaching Sound Receivers in Grade 8.	A	The teacher asks students to conduct activity to measure the speed of sound with enough preliminary experiment.
	B	The teacher asks students to memorize the names of all parts of the ear.
	C	The teacher asks students to memorize the level of sound in decibel produced by music instruments.
	D	All the teacher has to do is to give students the equation of speed of sound and some exercise.

Appendix 4 Test questions for RTTC trainers' understanding check Physics

Physics
Grade 9

Questionnaire
(Check ☑ in Yes or No)

Name of your school

Your name

Date
DD/MM/2015

Teaching "Wheel & Gear" (Chapter 2-3)

Question		Please circle one of the options.	
1	Among A, B, C and D on the right, please choose only one option that you think most appropriate statement in teaching Wheel & Gear in Grade 9.	A	The teacher explain as much detail of calculation as possible related to Drive belt.
		B	The teacher just asks students to memorize formula to calculate mechanical advantage.
		C	It is not necessary for the teacher to give students many exercises to find mechanical advantage because the calculation is very difficult.
		D	Level of contents in this chapter is more than high school level. The teacher have students understand basic information in this topic and can calculate simple questions.

Teaching "Straight proportion of Light" (Chapter 5-1)		
Question	**Please circle one of the options.**	
2 Among A, B, C and D on the right, please choose only one option that you think most appropriate in teaching Straight proportion of Light in Grade 9.	A	The teacher does not necessary to provide experiment in this topic because the light travel in the straight line is trivial.
	B	The teacher give students the experiment to find the light travel in the straight line by using improvised materials.
	C	The teacher explain the principle of the Lunar Eclipse and asks students to repeat until they memorize the whole thing.
	D	The teacher explain the formation of a picture formed in a darkroom to students just using picture in the textbook.

Appendix 4 Test questions for RTTC trainers' understanding check Mathematics

Questions on Teacher's Guide Vol.1

MATHEMATICS

RTTC: **Phnom Penh** **Kandal** **Takeo** **Kampong Cham** **Prey Veng** **Battambang**

Your name:

Grade 7 — Measurement (Lesson 7)

Question	Please circle one of the options.	
1 Among A, B, C and D on the right, please choose only one option that you think most appropriate in teaching measurement in Grade 7.	**A**	The teacher needs to give equal time to all the unit of measurement because units are equally important.
	B	The teacher needs to include hands-on activities that help students realise length, weight, volume and time.
	C	The teacher needs to instruct the units of time in the order of second-hour-minute-day as given in the textbook.
	D	Students have to memorize all the units of measurement in this lesson.

Grade 8 — Measurement (Lesson 4)

Question	Please circle one of the options.	
2 Among A, B, C and D on the right, please choose only one option that you think most appropriate in teaching measurement in Grade 8.	**A**	In teaching compound units, the teacher introduces a wider variety of examples that are not in the textbook.
	B	In teaching calculation of measurement, the teacher makes students memorize the formula first.
	C	In solving a problem on measurement, the teacher only shows the calculation process according to the textbook.
	D	In doing calculations, the teacher does not allow students to use calculators so as to develop their calculation skills.

Grade 9 — Proportion (Lesson 2)

Question	Please circle one of the options.	
3 Among the options A, B, C and D on the right, choose one option that you think is the most appropriate way to teach the following problem on page 23 of the textbook. "Find the cost price when the selling price is 3600 riels after 40% discount."	**A**	The teacher encourages students to memorize the calculation process given in the textbook.
	B	The teacher encourages students to solve it through group work.
	C	The teacher encourages students to draw figures so as to understand the conditions given in the problem.
	D	The teacher explains the problem through role-play with use of real objects.

Appendix 4 Test questions for RTTC trainers' understanding check Mathematics

Questions on Teacher's Guide Vol.2

MATHEMATICS

RTTC: **Phnom Penh** **Kandal** **Takeo** **Kampong Cham** **Prey Veng** **Battambang**

Your name:

Grade 7 — Probability (Lesson 20)

Question		Please circle one of the options.
1 Now you roll a die once. Among A, B, C and D on the right, please choose only one option that you think the reason for the probability of rolling a 1 is 1/6 (one sixth).	**A**	It is because there are 6 faces in a die.
	B	It is because when we roll a die, 1 appears exactly once in 6 times.
	C	It is because if we roll a die very many times, then the probability of rolling a 1 approaches 1/6.
	D	It is because of the definition.

Grade 8 — Probability (Lesson 11)

Question		Please circle one of the options.
2 Among A, B, C and D on the right, please choose only one option that you think most appropriate in teaching probability in Grade 8.	**A**	The teacher focuses on doing exercises in the textbooks rather than activities to count all the cases.
	B	The teacher avoids using a tree diagram because it will be taught in Grade 9.
	C	The teacher avoids re-arranging the order of exercises in the textbook as these are given in an appropriate order.
	D	The teacher encourages students to use tree diagrams to held students develop thinking skills.

Grade 9 — Probability (Lesson 8)

Question		Please circle one of the options.
3 The question below is Model Exercise 4 on page 88. Among the options A, B, C and D on the right, choose one option that describes this exercise. "In a bag, there are 15 marbles, the colour of which is white or black. When we drew 1 marble from the bag 100 times with replacement, we got a black marble 40 times out of 100 times. Find the number of black and white marbles."	**A**	In this exercise, there is a confusion between ratio and probability, and we cannot say how many black and white marbles are. Thus this exercise should be excluded from the lesson.
	B	Because 40/100 = 2/5, the number of black balls is 15 × 2/5 = 6 and so there are 15 - 6 = 9 white marbles.
	C	This exercise should be given after students have solved many basic exercises.
	D	The use of real marbles will help students find the answers (6 black and 9 white marbles).

Appendix 4 Test questions for RTTC trainers' understanding check Mathematics

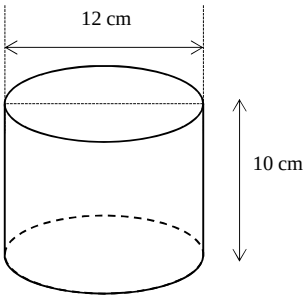
Questions on Teacher's Guide Vol.3

MATHEMATICS

RTTC: **Phnom Penh** **Kandal** **Takeo** **Kampong Cham** **Prey Veng** **Battambang**

Your name:

Grade 7 — Volume and surface area of solids (Lesson 18)

Question	Please circle one of the options.	
1 What is the volume of this cylinder? Choose one of the options from A to D on the right. 	**A**	$12 \times 12 \times 10 \times \pi = 1440\ \pi$ (cubic centimetres)
	B	$12 \times 10 = 120$ (cubic centimetres)
	C	$12 \times 10 \times \pi = 120\ \pi$ (cubic centimetres)
	D	$6 \times 6 \times 10 \times \pi = 360\ \pi$ (cubic centimetres)

Grade 8 — Statistics (Lesson 10)

Question	Please circle one of the options.	
2 Among A, B, C and D on the right, which do you think is the most appropriate description about the difference between a histogram and a bar chart?	**A**	A bar chart describes the frequency by the area, while a histogram by the height.
	B	A histogram is an another name of a bar chart, so there is no difference.
	C	A histogram describes the frequency by the area, but a bar chart by the height.
	D	A histogram only shows the data vertically but a bar chart can be shown both vertically and horizontally.

Grade 9 — Linear Equation (Lesson 10)

Question	Please circle one of the options.	
3 All the sentences A, B, C and D on the right are written about the equations for straight lines. Please choose <u>only one</u> sentence that is **NOT** correct.	**A**	The straight line $y = ax + b$ is obtained by moving the straight line $y = ax$ by b units along the y-axis.
	B	We can use Pythagoras' theorem to prove that $y = ax$ and $y = cx$ intersect perpendicularly if $ac = -1$.
	C	If $a = 0$ in the equation of $y = ax + b$, then the straight line will be parallel to the x-axis.
	D	If three points are given on a plane, we can always draw a straight line that passes through these three points.

Appendix 4 Test questions for RTTC trainers' understanding check Mathematics

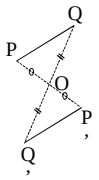
Questions on Teacher's Guide Vol.4

MATHEMATICS

RTTC: **Phnom Penh** **Kandal** **Takeo** **Kampong Cham** **Prey Veng** **Battambang**

Your name:

Grade 7 **Reflection (Lesson 19)**

Question	Please circle one of the options.	
2 The Grade 7 textbook says that if points P' and Q' are the reflection of points P and Q with respect to the point O, then the line PQ is parallel to the line P'Q'. Among A, B, C and D on the right, chose only one option that you think most appropriate in teaching this fact. 	**A**	The teacher should be careful in teaching this fact because to understand this requires the knowledge to be learnt in Grade 8.
	B	The teacher should follow the textbook' instruction because this description has no problem.
	C	The teacher should give more examples related to this fact to help students understand clearly.
	D	The teacher should conduct group work to examine this fact.

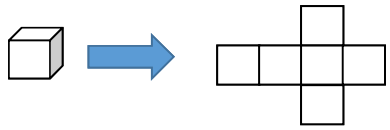
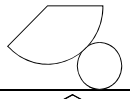
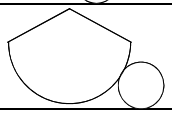
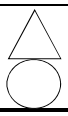
Grade 8 **Comparison of Triangles (Lesson 12)**

Question	Please circle one of the options.	
3 Among A, B, C and D on the right, which do you think is the dfinition of congruent triangles?	**A**	The condition SSS holds. (Other 2 conditions are deribed from SSS.)
	B	One of the conditions among SSS, SAS, and ASA holds.
	C	One triangle can be overlapped completely with the other.
	D	All the three angles are congruent.

Grade 8 **Scale (Lesson 18)**

Question	Please circle one of the options.	
4 Among A, B, C and D on the right, please choose <u>only one</u> option that you think most appropriate in teaching probability in Grade 8.	**A**	The teacher encourages students to draw reduced figures of a real objects on their notebook.
	B	The teacher focuses on the calculation from one scale to another as in the textbook rather than scale drawing.
	C	The teacher introduces enlarged and reduced figures as similar figures.
	D	The teacher gives importance to the terms such as strategic map and topographical map that are in the textbook.

Grade 9 **Solid Figures (Lesson 18)**

Question	Please circle one of the options.	
5 The net of a cube is as shown below.  What will be the net of the following cone? 	**A**	
	B	
	C	
	D	

Appendix 4 Test questions for RTTC trainers' understanding check Mathematics

Questions on Teacher's Guide Vol.5

MATHEMATICS

RTTC: **Phnom Penh** **Kandal** **Takeo** **Kampong Cham** **Prey Veng** **Battambang**

Your name:

Grade 7 — Parallel lines, parpendicular lines (Lesson 14)

Question		Please circle one of the options.
1 On the textbook, there is a question to show that if two lines d1 and d2 are parallel and the third line d3 is parallel to d1, then d3 is also parallel to the second line d2. About the instruction about this question, select one option from the right that you think is most appropriate fof Grade 7 student d1 —————— d2 —————— d3 ——————	**A**	The teacher deals with it as a "mathematical fact" without proof.
	B	The teahcer proves it in the way that: we know d1||d2 and d1||d3, therefore d2||d3.
	C	The teacher skips this question.
	D	The teacher proves it by showing that: if d2 is not parallel to d3, then there will be a contradiction.

Grade 7 — Two dimensional geometric shapes (Lesson 15)

Question		Please circle one of the options.
2 Among A, B, C and D on the right, choose one option that you think is the most appropriate way to teach the properties of rectangles to Grade 7 students.	**A**	The teacher and students together read aloud the properties of rectangles to facilitate memorisation.
	B	The teacher theoretically explains the properties of rectangles.
	C	The teacher has students fold and cut rectangle-shape papers to find the properties of rectangles.
	D	The teacher gives students sufficient time to individually consider why these properties hold.

Grade 8 — Proportion and percent (Lesson 3)

Question		Please circle one of the options.
3 Among A, B, C and D on the right, choose one option that you think is the most appropriate way to teach the proportional relationship y = ax to Grade 7 students.	**A**	The teacher uses abstract expression and explains theoretically as in the textbook.
	B	The teacher introduces it through concrete examples and uses a table to show the relationship between x and y.
	C	The teacher gives students sufficient time to memorise the relationship y = ax.
	D	The teacher has students work in group to discuss the meaning of the relationship y = ax.

Grade 8 **Lines and Special Segments Intersecting in a Triangle (Lesson 16)**

Question		Please circle one of the options.
4 Among the options A, B, C and D, choose one option that you think is TRUE about centroid, circumcenter, orthocenter and incenter in a right-angle triangle.	**A**	The centroid of a right-angle triangle does not exist.
	B	The orthocenter of a right-angle triangle is a vertex of the triangle.
	C	The circumcenter of a right-angle triangle is outside the triangle.
	D	The incenter of a right-angle triangle is on a side of the triangle.

Grade 9 **Statistical Mean (Lesson 7)**

Question		Please circle one of the options.
5 Suppose that we have data of the number of children of five families: 2 4 1 3 4. Among the options A, B, C and D, choose one option that you think is the most appropriate description of the mean value of the data.	**A**	The mean value of the data is calculated as 2.8, but it is not real mean because the number of children must be an integer.
	B	The mean value of the data is 2.8 and it contains all the information of the data.
	C	The mean value of the data is 2.8. But we should use the mode=4 instead of the mean value, since the number of children must be an integer.
	D	The mean value of the data is 2.8 and it represents some tendency of the data as a whole.

Grade 9 **Circles and Lines (Lesson 13)**

Question		Please circle one of the options.
6 Among the options A, B, C and D, choose one option that you think is the most appropriate way to teach that a tangent line of a circle is perpendicular to the radius.	**A**	The teacher writes the sentence “A tangent line is perpendicular to the radius” on the blackboard and let students read and repeat until they fully memorize the fact.
	B	The teacher lets students read the textbook and wait until all the students say that they understand the proposition.
	C	The teacher draws or has students draw the figure of a circle and a chord and has students think what happens as the chord moves to the edge of the circle.
	D	The teacher lets students solve the problems of tangent lines without teaching the fact that a tangent line is perpendicular to the radius.