CHAPTER 4
RESULT OF THE STUDY

This chapter presents the results of the study which focused on developing the Teacher's Orientation to Teaching Science (TOTS) questionnaire to measure parts of teacher's Pedagogical Content Knowledge (PCK) considering the goal and characteristics of teaching. Moreover, this research aims to compare science teachers' PCK between Malaysia and Thailand by using the questionnaire and observing the science classrooms of the participating teachers to examine how their Orientation to Teaching Science is related to their teaching practice. The research methodology consisted of three main stages including research tool development, quantitative strand, and qualitative strand. Data gathered from research tool development included the outcomes of developing the questionnaire, and conducting field trial studies. In quantitative strand, the highest agreement and a trend of teachers' orientation to teaching science was reported. In addition, the qualitative data was presented here in this chapter to describe how teacher's orientation toward teaching science is related with teaching practice.

1. The results of research tool development

Items were developed to measure each orientation based on its operationlisation in terms of goals and teaching characteristics as stated in Table 1 (Chapter 3). At the initial stage, a total of 27 items were developed by the research team as shown in appendix1

Five raters were invited to review the suitability of the items that captured the conceptual meaning of Orientation toward Science Teaching scale. The purpose is to ensure the readability and comprehensibility. The first three raters were lecturers from different disciplines in the local higher education institutions; and the latter two raters were senior secondary science teachers. Several items were found inappropriate in terms of the problems of item structure, grammatical, and its generalisability to the broader context based on the comments from the raters. For instance, '*In the lesson about cell biology, the students follow the instruction in the laboratory manual to observe plant and animal cells using microscopes and carefully take notes in their lab notebook*.' was improved as '*I always teach my students to classify insects using a guidebook*.' The problematic items according to the comments given by the raters were refined and no items were excluded. Overall, the initial 54 items (Table 3) were retained and Orientation toward Science Teaching scale with 5-point Likert scale, ranging from strongly disagree (1) to strongly agree (5) was formed. Prior to designing the questionnaire, a preliminarily test was conducted on 10 secondary science teachers to ensure the appropriateness of question content, wording, sequence, format, layout, and instruction.

Table 3 A Thai version Orientations towards Teaching Science Scale

Orientation	Item	Description
Process	3	I always teach my students to classify insects using a guidebook.
	11	I always teach my students to use a microscope to observe plant or animal cells.
	12	I always teach my students to calculate the speed of a toy car by measuring distance and time.
	18	I always teach my students to measure mass and volume of a wood block to calculate density.
	29	I always teach my students to calculate the average height of plants.
	38	I always teach my students to observe chemical reactions.
Academic Rigor	16	I always demonstrates a scientific experiment to verify science concepts in textbooks.
	17	I always conduct demonstrations to verify science concepts.
	20	I always have my students do challenging science experiment.
	47	I always challenge my students with difficult assignments.
	51	I always challenge my students with difficult problems and activities in science.
	52	I always challenge my students to do an experiment to verify science concepts.
Didactic	1	I always use Power Point to present scientific concepts.
	24	I always use animation to illustrate the circulatory system.
	25	I always recites scientific facts to students.
	30	I always disseminate information through lectures.
	32	I always use video clip to present scientific facts.
	46	I always asks questions for students to recall facts.
Conceptual Change	6	I always compare students’ ideas with scientific conceptions.
	15	I always present evidence to make scientific knowledge plausible.
	19	I always use scientific evidence to convince the students to change

Orientation	Item	Description
		their misconceptions.
	33	I always use discrepant events to promote students' dissatisfaction with their naive conceptions.
	42	I always use a dianostic test to examine students' misconceptions.
	44	I always use questioning strategies to assess students' misconceptions.
Activity-driven	9	I always do hands-on activites in science class.
	10	I always have students play games in science class.
	35	I always encourage students to participate many learning activities.
	41	I always try to incorporate learning acitivity into the lesson plan.
	45	I always choose interesting learning activities in teaching.
	49	I always use role-play activities to teach chemistry.
Discovery	13	I believe that science learning activies should supports students' discovery.
	14	I found that students study the topic in which they are interested and discover scientific knowledge.
	22	I found that students discover the solution for local area pollution.
	23	I believe that "discovery learning" is an effective teaching method.
	48	I found that students always discover scientific knowledge from doing activities with their friends.
	50	I found that students discover scientific knowledge after analzing examples from the teacher.
Project-based Science	5	As a teacher, I used to choose a topic from newspapers to engage students to do science projects
	8	As a teacher, I used to propose questions to lead my students to design their science projects.
	27	I always encourage my students to work on science projects collaboratively.
	37	As a teacher, I used to choose a topic from newspapers to engage students to do science projects
	39	I have students present their work on science project.
	43	I let my students to select the topic for doing science projects.
Inquiry	4	I always encourage my students to formulate questions for inquiry learning.

Orientation	Item	Description
	20	I always have my students do challenging science experiment.
	26	I always encourage my students to give priority to evidence when they are doing scientific experiments.
	31	I always encourage my students to communicate their findings and evidence to the public in various ways.
	53	I always encourage my students to search information on the Internet to use in lab reports.
	54	I always encourage my students to collect data to support their hypothesis.
Guided Inquiry	2	I always guide the students to design an experiment to test their scientific ideas.
	7	I guide the students to investigate scientific questions.
	21	I always pose a scientific question to engage students in inquiry learning.
	34	I always guide the students to design experiments to answer my questions.
	36	I always formulate scientific questions with my students collaboratively.
	40	I always guide my students to choose the method for testing their hypotheses.

2. The results of quantitative strand

2.1 The result from Thai teachers

Table 2 shows the assumptions of unidimensionality and local independency was satisfied with the values with the eigenvalue of first contrast less than 2.0 and the raw variance explained by measures more than 40% (Bond & Fox, 2007; Linacre & Wright, 1999) and the largest standardised residual correlations used to identify the dependent among items within each scale examined were less than .70. All the point-measure correlation exhibited as positive values. However, a total of 11 misfit item were found with the logit units beyond the acceptable range of mean squares standardized z-scores. The misfit items included Item 17 and 20 (Academic Rigor), Item 30 (Didactic), Item 15 (Conceptual), Item 10 and 41 (Activity-driven), Item 43 (Project-based science), Item 26, 53 (Inquiry) as well as Item 36 and Item 40 (Guided

Inquiry). These misfit items were suggested to be excluded from further analysis. Overall, a total of 43 out of 54 items were found reliable and valid based on the Thai data.

Table 4 Individual Item Fit Statistics of Rasch Analysis

Orientation	Item	Measure	SE	Infit MNSQ (ZSTD)	Outfit MNSQ (ZSTD)	Point-measure correlation	UNI	LI
Process	3	1.55	0.18	1.07(0.50)	1.09(0.60)	0.67	√	√
	11	0.31	0.30	0.91(-0.30)	0.99(0.10)	0.65		
	12	-0.47	0.17	0.92(-0.50)	0.94(-0.30)	0.61		
	18	-0.72	0.28	0.78(-0.90)	0.79(-0.90)	0.81		
	29	-0.60	0.17	1.05(0.40)	1.04(0.30)	0.71		
	38	-0.61	0.28	1.07(0.40)	1.06(0.30)	0.83		
Academic	16	0.90	0.20	1.01(0.10)	1.01(0.10)	0.63	√	√
	17	-2.48	0.31	**1.77(2.80)**	**1.74(2.60)**	0.46		
	20	1.72	0.19	**0.66(-2.40)**	**0.68(-2.20)**	0.72		
	47	-1.08	0.29	1.12(0.60)	1.09(0.40)	0.56		
	51	2.55	0.19	0.92(-0.50)	0.93(-0.40)	0.78		
	52	-1.61	0.30	0.99(0.10)	0.95(-0.10)	0.60		
Didactic	1	0.01	0.14	0.94(-0.40)	0.94(-0.30)	0.56	√	√
	24	-0.13	0.23	0.80(-0.80)	0.85(-0.60)	0.74		
	25	-0.79	0.15	1.05(0.40)	1.02(0.20)	0.70		
	30	-0.89	0.24	**1.50(1.90)**	**1.45(1.70)**	0.58		
	32	0.64	0.14	0.95(-0.30)	0.95(-0.30)	0.63		
	46	1.16	0.22	0.90(-0.40)	0.87(-0.50)	0.70		
Conceptual	6	0.83	0.20	0.94(-0.40)	0.93(-0.50)	0.74	√	√
	15	1.02	0.32	**1.80(2.90)**	**1.84(3.00)**	0.67		
	19	-1.01	0.21	0.84(-1.10)	0.88(-0.70)	0.78		
	33	-1.20	0.34	0.99(0.00)	0.89(-0.30)	0.72		
	42	0.20	0.21	0.84(-1.10)	0.85(-1.00)	0.75		
	44	0.16	0.33	1.09(0.50)	1.10(0.50)	0.72		
Activity	9	-1.00	0.19	0.74(-1.80)	0.78(-1.50)	0.77	√	√
	10	0.20	0.28	**1.86(3.10)**	**1.78(2.90)**	0.66		
	35	1.50	0.17	0.89(-0.70)	0.93(-0.40)	0.73		

Orientation	Item	Measure	SE	Infit MNSQ (ZSTD)	Outfit MNSQ (ZSTD)	Point-measure correlation	UNI	LI
	41	1.53	0.27	**1.71(2.70)**	**1.67(2.50)**	0.52		
	45	-0.82	0.19	0.76(-1.70)	0.83(-1.10)	0.69		
	49	-1.41	0.30	0.63(-1.60)	0.60(-1.50)	0.76		
Discovery	13	-0.46	0.22	0.82(-1.20)	0.80(-1.10)	0.74	√	√
	14	-2.00	0.38	0.91(-0.30)	1.08(0.40)	0.67		
	22	0.17	0.21	0.95(-0.20)	0.94(-0.30)	0.76		
	23	-1.03	0.36	0.97(0.00)	1.00(0.10)	0.78		
	48	2.34	0.19	1.06(0.40)	1.07(0.50)	0.79		
	50	0.98	0.31	1.29(1.20)	1.36(1.40)	0.78		
Project	5	0.55	0.18	1.07(0.50)	1.06(0.40)	0.78	√	√
	8	0.28	0.30	0.63(-1.60)	0.63(-1.50)	0.80		
	27	0.34	0.19	0.92(-0.40)	0.91(-0.50)	0.78		
	37	0.28	0.30	1.14(0.60)	1.13(0.60)	0.82		
	39	-0.84	0.20	0.85(-1.00)	0.88(-0.80)	0.81		
	43	-0.61	0.32	**1.69(2.20)**	**1.61(2.00)**	0.56		
Inquiry	4	0.44	0.23	0.96(-0.20)	0.92(-0.40)	0.71	√	√
	26	-0.49	0.34	**1.51(1.60)**	**1.59(1.80)**	0.72		
	28	1.42	0.21	0.79(-1.30)	0.85(-0.80)	0.75		
	31	-1.71	0.37	1.52(1.70)	1.59(1.80)	0.52		
	53	1.36	0.21	**0.79(-1.20)**	**0.61(-2.40)**	0.81		
	54	-1.02	0.35	0.98(0.00)	0.82(-0.50)	0.71		
Guided	2	0.98	0.16	0.75(-1.80)	0.77(-1.70)	0.81	√	√
	7	1.04	0.27	0.80(-0.80)	0.76(-1.00)	0.86		
	21	-0.17	0.18	0.91(-0.50)	0.96(-0.20)	0.59		
	34	-0.62	0.30	1.21(0.90)	1.16(0.70)	0.72		
	36	-0.71	0.19	**0.68(-2.20)**	**0.71(-2.00)**	0.76		
	40	-0.53	0.30	**2.53(4.30)**	**2.47(4.20)**	**0.44**		

Note: UNI indicates unidimensionality, LI indicates local independency.

Table 4 shows the results of the chi-square test supports the data for each orientation fitted the model. Table 3 reveals the satisfactory level of item reliability ranged from 0.76 to

0.98. This result indicated that the item difficulty range and/or the sample size was appropriate. However, the person reliability failed to achieve the satisfactory level except the orientation of Academic Rigor with the alpha value of .80. A possible reason to explain the relatively lower alpha's value of person reliability is that the participants tend to have the same opinion regarding to each orientation.

Table 5 Item and Person Measures Summary Statistics for Thai data

Orientations	Mean (SD)		Reliability		Chi-square
	Person	Item	Person	Item	
Process	-0.54(1.68)	0.00(0.78)	0.63	0.90	χ^2 (125,366) =655.98*
Academic Rigor	2.04(2.37)	0.00(1.84)	0.80	0.98	χ^2 (125,376) =611.73*
Didactic	0.45(1.21)	0.00(0.73)	0.53	0.93	χ^2 (125,366) =803.45*
Conceptual Change	1.04(2.11)	0.00(0.84)	0.70	0.89	χ^2 (125,373) =546.53*
Activity-driven	2.30(1.66)	0.00(1.17)	0.63	0.96	χ^2 (125,372) =637.43*
Discovery	3.39(2.27)	0.00(1.40)	0.71	0.96	χ^2 (125,347) =518.17*
Project-based Science	1.96(2.20)	0.00(0.52)	0.74	0.76	χ^2 (125,354) =588.15*
Inquiry	3.12(2.36)	0.00(1.17)	0.70	0.94	χ^2 (125,353) =489.27*
Guided Inquiry	1.79(1.75)	0.00(0.73)	0.65	0.89	χ^2 (125,368) =644.59*

Note: * $p < .001$

Table 5 also shows the mean person measures are higher than the mean item measures for eight orientations except Process. This indicated that the person ability was higher than the item difficulty across the orientation of Academic Rigor, Didactic, Conceptual Change, Activity-driven, Discovery, Project-based Science, Inquiry, and Guided Inquiry.

2.2 The result from Malaysian teachers

Table 4 shows the assumptions of unidimensionality and local independency was satisfied across the eight orientations to science teaching except Academic Rigor. The results indicated the items of Academic Rigor which developed based on Thai context was not applicable in Malaysian science teacher context. The eight orientations appeared with the values with the eigenvalue of first contrast less than 2.0 and the raw variance explained by measures more than 40% (Bond & Fox, 2007; Linacre & Wright, 1999) and the largest standardised residual correlations used to identify the dependent among items within each scale examined were less than .70. All the point-measure correlation exhibited as positive values. However, a total of 7 misfit item were found with the logit units beyond the acceptable range of mean squares standardized z-scores. The misfit items included Item 12 (Process), Item 1 and 30 (Didactic), Item 49 (Activity-driven), Item 48 (Discovery), Item 37 (Project-based science) and Item 54 (Inquiry). The seven misfit items were suggested to be excluded from further analysis. Overall, a total of 41 out of 54 items were found reliable and valid based on the Malaysian data.

Table 6 Individual Item Fit Statistics of Rasch Analysis for Malaysia data

Orientation	Item	Measure	SE	Infit MNSQ (ZSTD)	Outfit MNSQ (ZSTD)	Point-measure correlation	LI	UNI
Process	3	1.11	0.16	0.94(-0.40)	0.97(-0.10)	0.63	√	√
	11	0.83	0.18	0.73(-1.80)	0.85(-0.80)	0.78		
	12	-0.49	0.17	**1.37(2.30)**	1.24(1.50)	0.68		
	18	-0.81	0.19	0.87(-0.70)	0.89(-0.60)	0.76		
	29	-0.62	0.17	1.21(1.30)	1.10(0.70)	0.70		
	38	-0.02	0.18	0.74(-1.70)	0.74(-1.60)	0.78		
Academic	16	1.41	0.23	0.76(-1.20)	0.62(-1.60)	0.77	×	×
	17	-2.26	0.24	0.86(-0.50)	0.81(-0.60)	0.65		
	20	2.05	0.20	**0.66(-2.00)**	**0.51(-2.10)**	0.80		
	47	-1.89	0.24	**0.48(-2.70)**	**0.38(-2.40)**	0.69		
	51	2.00	0.20	**1.70(3.30)**	1.32(1.20)	0.68		
	52	-1.32	0.21	1.17(0.80)	1.24(0.80)	0.74		
Didactic	**1**	0.02	0.17	**1.46(2.40)**	**1.47(2.40)**	0.65	√	√

Orientation	Item	Measure	SE	Infit MNSQ (ZSTD)	Outfit MNSQ (ZSTD)	Point-measure correlation	LI	UNI
	24	0.43	0.15	0.95(-0.30)	0.88(-0.70)	0.68		
	25	0.73	0.16	1.07(0.50)	1.05(0.40)	0.75		
	30	-0.45	0.16	**0.64(-2.60)**	**0.66(-2.00)**	0.66		
	32	0.03	0.17	0.93(-0.30)	1.01(0.10)	0.63		
	46	-0.77	0.17	0.77(-1.40)	0.83(-0.90)	0.50		
Conceptual	6	3.74	0.23	1.04(0.30)	0.93(-0.20)	0.69	√	√
	15	-3.83	0.27	1.01(0.10)	0.86(-0.40)	0.68		
	19	2.49	0.27	0.82(-0.90)	.81(-0.70)	0.75		
	33	-3.83	0.28	0.71(-1.30)	0.54(-1.70)	0.64		
	42	3.94	0.23	1.07(0.50)	1.05(0.30)	0.76		
	44	-2.51	0.23	1.00(0.10)	0.95(-0.10)	0.66		
Activity	9	0.40	0.22	1.28(1.50)	1.34(1.60)	0.66	√	√
	10	-1.37	0.21	0.91(-0.40)	0.87(-0.50)	0.62		
	35	3.42	0.17	1.00(0.10)	0.95(-0.20)	0.79		
	41	0.19	0.18	0.72(-1.80)	1.01(0.10)	0.82		
	45	-0.32	0.23	0.95(-0.20)	1.08(0.40)	0.70		
	49	-2.31	0.24	**0.59(-2.20)**	0.64(-1.60)	0.63		
Discovery	13	-1.65	0.26	0.97(-0.10)	1.01(0.10)	0.69	√	√
	14	-0.39	0.28	0.77(-1.10)	0.64(-1.70)	0.71		
	22	-2.61	0.25	0.86(-1.00)	0.78(-0.90)	0.71		
	23	0.40	0.26	1.23(1.10)	1.27(1.10)	0.44		
	48	2.20	0.20	1.16(1.00)	**1.40(2.10)**	0.63		
	50	2.05	0.22	0.72(-1.60)	0.83(-0.80)	0.88		
Project	5	1.87	0.18	0.83(-1.10)	0.81(-1.10)	0.80	√	√
	8	1.21	0.19	0.82(-1.10)	0.92(-0.40)	0.87		
	27	-1.32	0.22	1.20(1.20)	1.20(1.10)	0.67		
	37	-0.55	0.22	**0.59(-2.50)**	**0.50(-3.00)**	0.77		
	39	-1.11	0.22	1.24(1.40)	1.24(1.20)	0.57		
	43	-0.09	0.21	1.05(0.30)	1.05(0.30)	0.57		
Inquiry	4	0.35	0.20	1.17(0.90)	1.17(0.70)	0.59	√	√

Orientation	Item	Measure	SE	Infit MNSQ (ZSTD)	Outfit MNSQ (ZSTD)	Point-measure correlation	LI	UNI
	26	0.20	0.19	1.12(0.70)	1.24(0.90)	0.70		
	28	-1.18	0.25	1.08(0.50)	1.11(0.60)	0.54		
	31	-0.17	0.21	0.79(-1.00)	0.79(-0.80)	0.58		
	53	0.64	0.18	1.04(0.30)	0.93(-0.20)	0.69		
	54	0.16	0.19	**0.49(-2.20)**	0.73(0.66)	0.73		
Guided	2	0.75	0.20	1.01(0.10)	1.05(0.30)	0.83	√	√
	7	0.50	0.22	0.99(0.00)	0.80(-0.70)	0.83		
	21	-1.03	0.26	1.09(0.50)	0.90(-0.40)	0.63		
	34	-0.49	0.26	0.86(-0.50)	0.84(-0.60)	0.59		
	36	-0.14	0.23	1.16(0.80)	0.95(-0.10)	0.66		
	40	0.40	0.23	0.79(-1.00)	0.69(0.69)	0.66		

Note: LI indicates local independency, UNI indicates unidimensionality.

Table 6 shows the results of the chi-square test supports the data for each orientation fitted the model. Table 5 reveals the satisfactory level of item reliability ranged from 0.86 to 0.99. This result indicated that the item difficulty range and/or the sample size was appropriate. However, the person reliability failed to achieve the satisfactory level except the orientation of Conceptual change and Activity-driven with the alpha value of .80 and above. A possible reason to explain the relatively lower alpha’s value of person reliability is that the participants tend to have the same opinion regarding to each orientations.

Table 7 Item and Person Measures Summary Statistics

Orientations	Mean (SD)		Reliability		Chi-square
	Person	Item	Person	Item	
Process	-0.33(1.66)	0.00(0.73)	0.63	0.94	χ^2 (167, 471) =867.96*
Didactic	0.43(1.64)	0.00(0.50)	0.63	0.89	χ^2 (167, 471) =848.88*
Conceptual Change	1.73(4.54)	0.00(3.45)	0.89	0.99	χ^2 (167, 468) =518.40*
Activity-driven	2.38(2.61)	0.00(1.79)	0.80	0.99	χ^2 (167, 486) =669.52*
Discovery	2.91(2.12)	0.00(1.77)	0.59	0.98	χ^2 (167, 347) =518.17*
Project-based Science	2.05(2.05)	0.00(1.17)	0.68	0.97	χ^2 (167, 496) =730.15*
Inquiry	1.77(1.94)	0.00(0.58)	0.55	0.87	χ^2 (167, 484) =663.52*
Guided Inquiry	2.54(2.06)	0.00(0.62)	0.55	0.86	χ^2 (167, 481) =591.98*

Note: * $p < .001$

Table 7 also shows the mean person measures are higher than the mean item measures for eight orientations except Process. This indicated that the person ability was higher than the item difficulty across the orientation of Didactic, Conceptual Change, Activity-driven, Discovery, Project-based Science, Inquiry, and Guided Inquiry.

2.3 The comparison between two countries

After transform raw data to Rarch data, the results from both countries were compared. First, The results from the questionnaire were analyzed to find the highest agreement and trend of teachers' orientation to teaching science. Second, the highest agreement and trend of teachers' orientation to teaching science from two countries were compared to describe the similarities and differences among the participating teachers. Those results are presented as follows;

1. The highest agreement and trend of teachers' orientation to teaching science.

In order to analyze the highest agreement of teachers' orientation to teaching science, we ranked the mean score of each orientation and looked for the order of the orientation.

1.1 Results from Malaysian Teachers

The highest agreement of orientation of teaching science of Malaysian teachers was discovery learning followed by guided inquiry, project-based inquiry and inquiry. The result was presented in table 8.

Table 8 Orientation to Teaching Science of Malaysian Teachers

	Minimum	Maximum	Mean	Std. Deviation
Discovery learning	-4.39	9.54	3.5145	2.10591
Guided inquiry	-3.40	7.65	2.5449	2.06906
Project-based science	-2.68	8.68	2.3605	2.55904
Inquiry	-.85	7.22	1.9502	1.75729
Activity driven	-5.59	10.21	1.8421	3.80568
Conceptual change	-8.32	10.01	1.7282	4.54873
Didactic	-3.30	4.41	.3227	1.89373
Process	-4.13	4.42	-.3080	1.72970

*Academic Rigor orientation was not included in this analysis because according to the RARCH analysis, the items of Academic Rigor which developed based on Thai context was not applicable in Malaysian science teacher context.

To analyze the trend of Malaysian teachers' orientation to science teaching, the orientations were categorized into 3 groups including teacher-centered orientations (T-C), 1960s student-centered orientations (1960s S-C), and contemporary student-centered orientations (CS-C). Didactic and Academic rigor orientations are teacher-centered orientations. Process, activity-driven, and discovery orientations are student-centered orientations. Conceptual change, project-based science, inquiry, and guided inquiry are student-centered orientations that represent contemporary reform efforts and curriculum projects. (Friedrichsen, 2011). Then, descriptive analysis for each group was calculated. The result is presented in table 9.

Table 9 Orientation to Teaching Science of Malaysian Teachers categorized into 3 groups

Orientations	N	Mean	SD	Min	Max
Teacher-Centered (T-C) - Didactic	168	.32	1.89	-3.30	4.41
1960s Student-Centered (1960s S-C) - Process - Activity-driven - Discovery learning	504	1.68	3.11	-5.59	10.21
Contemporary Student-Centered (CS-C) Conceptual change - project-based science - inquiry - guided inquiry	672	2.14	2.95	-8.32	10.01
Total	1344	1.74	2.96	-8.32	10.21

One-way ANOVA was used to compare mean score of each group of orientations whether they are significantly different from each other. The result is presented in table 10.

Table 10 One-way ANOVA result from Malaysia data

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	449.841	2	224.920	26.594	.000
Within Groups	11341.465	1341	8.457		
Total	11791.306	1343			

P<.05

The result from the analysis showed that there is significantly difference among Malaysian teachers' orientation to teaching science. The next step of analysis is to find which pairs of the orientations that is different. The result from Post-hoc test indicated that the highest orientation, contemporary student-centered orientation, was different from the

1960s student-centered orientation, and the teacher-centered orientation. The result of Post-hoc test is presented in table 11.

Table 11 The result of Post-hoc test from Malaysia data

Orientations		Mean Difference	Std. Error	Sig.
T-C	1960s S-C	-1.36020*	.25908	.000
	CS-C	-1.82327*	.25085	.000
1960s S-C	T-C	1.36020*	.25908	.000
	CS-C	-.46308*	.17137	.019
CS-C	T-C	1.82327*	.25085	.000
	1960S-C	.46308*	.17137	.019

*. The mean difference is significant at the 0.05 level.

1.2 Results from Thai Teachers

The highest agreement of orientation of teaching science of Thai teachers was inquiry followed by project-based science, guided inquiry and discovery learning. The result was presented in table 12.

Table 12 Orientation to Teaching Science of Thai Teachers

Orientations	Minimum	Maximum	Mean	Std. Deviation
Inquiry	-3.12	7.45	3.36	2.36
Project-based science	-9.33	9.48	2.78	3.76
Guided inquiry	-7.12	7.95	2.50	2.50
Discovery	-3.3	6.79	2.45	1.77
Academic rigor	-4.56	7.14	1.91	2.31
Activity driven	-5.6	6.34	1.60	2.04
Conceptual change	-9.04	12.39	0.80	5.06
Didactic	-0.96	3.36	0.52	0.77
Process	-4.58	4.59	-0.47	1.33

To analyze the trend of Thai teachers' orientation to science teaching, the orientations were categorized into 3 groups including teacher-centered orientations (T-C), 1960s student-centered orientations (1960s S-C), and contemporary student-centered orientations (CS-C). Didactic and Academic rigor orientations are both teacher-centered orientations (Friedrichsen, 2011) Process, activity-driven, and discovery orientations are student-centered orientations. Conceptual change, project-based science, inquiry, and guided inquiry are student-centered orientations that represent contemporary reform efforts and curriculum projects (Friedrichsen, 2011). Then, descriptive analysis for each group was calculated. The result is presented in table 13

Table 13 Orientation to Teaching Science of Thai Teachers categorized into 3 groups

Orientations	N	Mean	Std. Deviation	Min	Max
Teacher-Centered (T-C)	529	1.22	1.86	-4.56	7.14
- Didactic					
- Academic rigor					
1960s Student-Centered (1960s S-C)	795	1.19	2.13	-5.60	6.79
- Process					
- Activity-driven					
- Discovery learning					
Contemporary Student-Centered (CS-C)	1060	2.36	3.71	-9.33	12.39
- Conceptual change					
- Project-based science					
- Inquiry					
- Guided inquiry					
Total	2384	1.72	2.95	-9.33	12.39

One-way ANOVA was used to compare mean score of each group of orientations whether they are significantly different from each other. The result is presented in table 14.

Table 14 One-way ANOVA result from Thai data

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	789.835	2	394.917	47.072	.000
Within Groups	19975.911	2381	8.390		
Total	20765.746	2383			

The result from the analysis showed that there is significantly difference among Thai teachers' orientation to teaching science. The next step of analysis is to find which pairs of the orientations that is different. The result from Post-hoc test indicated that the highest orientation, contemporary student-centered orientation, was different from the 1960s student-centered orientation, and the teacher-centered orientation. The result of Post-hoc test is presented in table 15.

Table 15 The result of Post-hoc test of Thai data

Orientations		Mean Difference	Std. Error	Sig.
T-C	1960s S-C	.02147	.16252	.990
	CS-C	-1.14531*	.15419	.000
1960s S-C	T-C	-.02147	.16252	.990
	CS-C	-1.16678*	.13590	.000
CS-C	T-C	1.14531*	.15419	.000
	1960S-C	1.16678*	.13590	.000

*. The mean difference is significant at the 0.05 level.

From these results, Contemporary-Students-Centered orientation was the highest agreement that is the ultimate goal of science teaching for Thai teachers. Other orientations including 1960s-Student-Centered orientation was less agreement. Not surprisingly, teacher-centered orientations was the lowest agreement of teaching goal in science.

2. Comparing the trends of teachers' orientation to teaching science from the two countries

From the results above, Contemporary-Students-Centered orientation was the highest agreement that is an ultimate goal of science teaching for both Malaysia and Thailand teacher participants. Although the result from Malaysian teachers indicated that 1960s Student-Centered orientation was less agreement comparing with the Contemporary Student-Centered, however it was still higher than Thai teachers 1960s Student-Centered orientation. Actually, for Thai teachers, there was no significantly difference between 1960s Student-Centered and Teacher-Centered orientations. Teacher Centered orientation for Thai teacher, therefore, was substantially higher agreement than this orientation for Malaysian teachers. Figure 2 present comparing the trends of teachers' orientation to teaching science from the two countries.

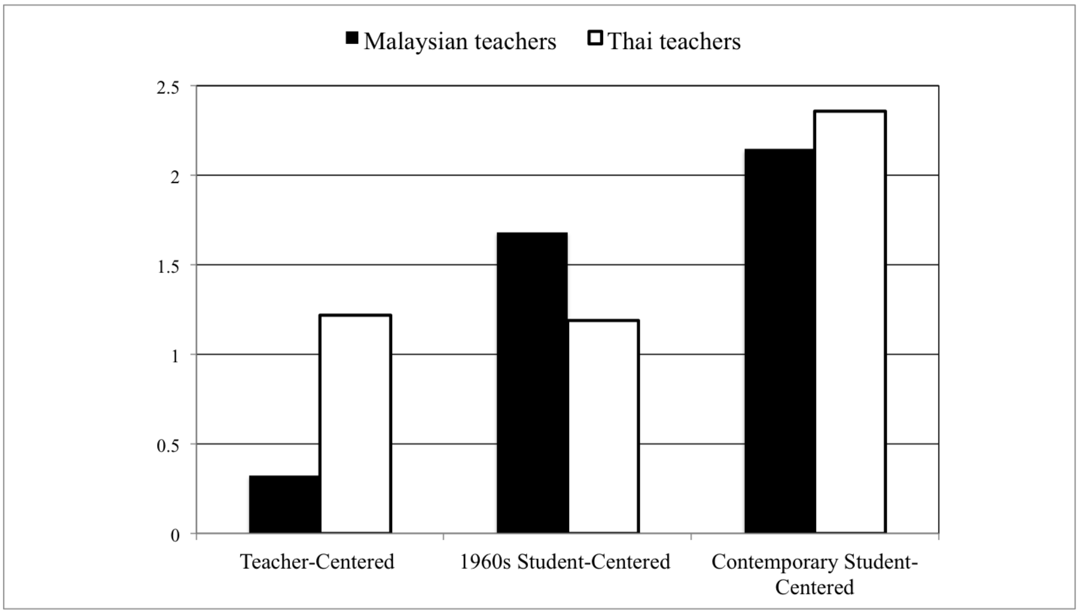

Figure 2 Trends of teachers' orientation to teaching science from the two countries

3. The results of qualitative strand

The main objective of this part was to examine how teacher's orientation toward teaching science is related to teaching practice. Two science teachers from Thailand and two science teachers from Malaysia answered Teacher's Orientation to Teaching Science (TOTS) questionnaire and allowed the researchers to observed their classrooms and conducted an interview. The results of this phase are as followed.

3.1 The result of Thai teachers

- Participating teachers responded to the TOTS questionnaire

The purpose of using TOTS questionnaire was to elicit teacher's ideas about teaching science, especially the preference of teaching objectives and methods related to science content. The result of thai teachers is presented in Figure 4 below.

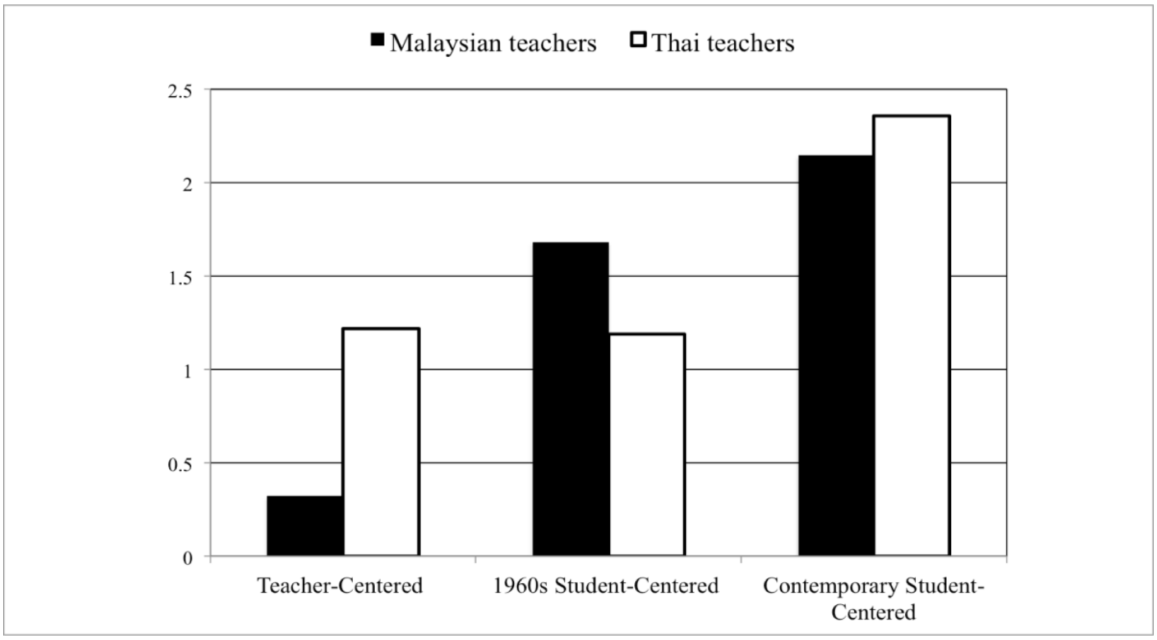

Figure 3 Thai Teacher's Orientation to Teaching science

Figure 3 show that both teachers tend to agree with Teacher Center orientation because there were highest agreement in Teacher Center. This group of orientation include didactic and academic rigor. For the didactic orientation, the teacher presents information, generally through lecture or discussion, and questions directed to students are to hold them accountable for knowing the facts produced by science. For the academic rigor, students are challenged with difficult problems and activities. Laboratory work and demonstrations are used to verify science concepts by demonstrating the relationship between particular concepts and phenomena.

- The researcher observed the participating teachers' classroom to collect data about classroom environment, learning activity and classroom management using the classroom observation form.

The result of this process indicated that Teacher T1 use laboratory activity to verify science concept. Before the activity, The teacher explained friction concept as the force that against object movement, then lab directions were distributed to the students. The teacher let the students read through it about 5 minuets and then summarised how to conduct the experiment. The students followed the direction steps by steps to verify scientific concept about friction. After the experiment, some groups of the students presented their finding. The teacher tried to guide the classroom discussion in the way that lead to science content. The teachers did not spend time discussing about the results from some groups that were not support science content. Instead of helping students understand how scientific knowledge could be constructed from analysing evidence, the teacher use science experiment to demonstrate scientific phenomena.

Teacher T2 use scientific investigation as the verification of science content more clearly than teacher T1. The teacher spend most of the time in class explaining science content regarding to chemical matter and how to separate them. Then, the student did experiment by following lab direction steps by steps. Lab discussion part of the activity aimed to use findings from the experiment to support science content

- Teacher's interviews were conducted to collect data related to the rationale of participating teachers in choosing classroom activities.

The teachers were asked to explain why they chose the activity in the lessons. Both of them stated that they used inquiry approach to teach science content because they want students to understand science more clearly.

“When the students conducted science laboratory, they would see the real things and get better understanding about science concepts”

“ I like to use laboratory a lot because the school greatly support me to do this and the students prefer more lab than lecture”

Interestingly, they had incomplete understanding about inquiry teaching which more focus on using evidence to explain phenomena or answer questions. The teachers use lab activities to demonstrate and very science content not to develop scientific explanation from evidence.

- All data was analysed in order to examine how teacher’s orientation toward teaching science is related to teaching practice.

There were the relationship between the teacher orientation to teaching science and teaching practice. Their orientation of teaching science were academic rigour and didactic. The teacher presents information, generally through lecture or discussion, and questions directed to know science contents. Lab activities were used to demonstrate and verify scientific ideas. These are the evidence of the consistency of the teaching orientation and practice.

3.2 The result from Malaysian teachers

- Participating teachers responded to the TOTS questionnaire

The purpose of using TOTS questionnaire was to elicit teacher’s ideas about teaching science, especially the preference of teaching objectives and methods related to science content. The result of Malaysian teachers is presented in Figure 5 below.

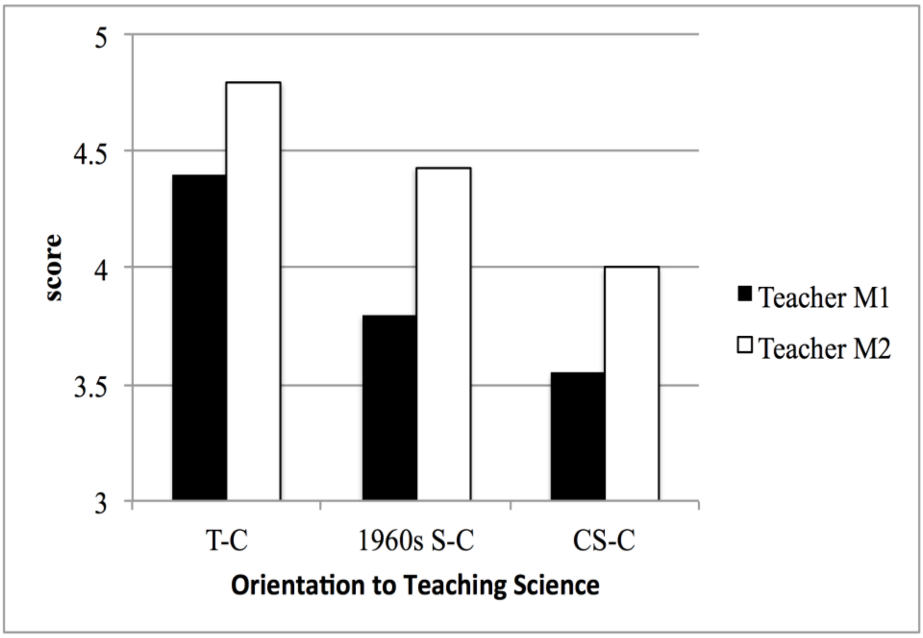

Figure 4 Malaysian Teacher's Orientation to Teaching Science

Figure 4 shows that both teachers tend to agree with Teacher Center orientation because there were highest agreement in Teacher Center. This group of orientation include didactic and academic rigor. For the didactic orientation, the teacher presents information, generally through lecture or discussion, and questions directed to students are to hold them accountable for knowing the facts produced by science. For the academic rigor, students are challenged with difficult problems and activities. Laboratory work and demonstrations are used to verify science concepts by demonstrating the relationship between particular concepts and phenomena.

- The researcher observed the participating teachers' classroom to collect data about classroom environment, learning activity and classroom management using the classroom observation form.

The result of this process indicated that ,again, Teacher M1 use laboratory activity to verify science concept. Before the activity, The teacher explained about series circuit and parallel circuit by using PowerPoint presentation. Then, students were divided into 6 groups to carry out lab activity regarding to series circuit and parallel circuit. The students followed the direction steps by steps to verify scientific concept about electricity. The teacher explained how to conduct the experiment. After the experiment, the students presented their results. The teacher tried to guide the classroom discussion in the way that lead to science content. No critical discussion on the experiment results.

- All data was analysed in order to examine how teacher's orientation toward teaching science is related to teaching practice.

There were the relationship between the teacher orientation to teaching science and teaching practice. Their orientation of teaching science were academic rigour and didactic. The teacher presents information, generally through lecture or discussion, and questions directed to know science contents. Lab activities were used to demonstrate and verify scientific ideas. These are the evidence of the consistency of the teaching orientation and practice.

4. Conclusion

This research aims to compare science teachers' PCK between Malaysia and Thailand by using the questionnaire and observing the science classrooms of the participating teachers to examine how their Orientation to Teaching Science is related to their teaching practice.

The results indicated that the highest agreement of orientation of teaching science of Malaysian teachers was discovery learning followed by guided inquiry, project-based inquiry and inquiry. After the orientations were categorised , the result showed that contemporary student-center was the highest agreement following by 1960s student-center, and teacher-center. For thai teachers, the highest agreement of orientation of teaching science of Thai teachers was inquiry followed by project-based science, guided inquiry and discovery learning. After the orientations were categorised, the result showed that contemporary student-center was the highest agreement following by 1960s student-center, and teacher-center.

The result from qualitative part supported the notion of the relationship between teacher's orientation to teaching science and classroom practice. The participating teachers design classroom activity based on their orientations.