CHAPTER 3
METHODOLOGY

The purpose of this study was to construct 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 following steps were used as research methodology in this study

1. Research participants
2. Research tools
3. Research method
4. Statistic and data analysis

1. Research participants

The participants in each phase of study were as follows:

1. Participating teachers in the development of research tools phase are 127 teachers who teach science in secondary school level in Thailand.

2. Participating teachers in the quantitative strand are 264 science teachers from Thailand and 167 science teachers from Malaysia. Those participants are in-service teachers from all over the countries who intently volunteer to give their information for this research. They responded to the Teacher's Orientation to Teaching Science questionnaire (TOTS).

3. Participating teachers in the qualitative strand are selected from the result of the previous phase of study. The main objective of this part is to examine how teacher's orientation to teaching science is related to teaching practice. 2 science teachers from Thailand and 2 science teachers from Malaysia allowed the researchers to observed their classrooms and conduct an interview.

2. Research tools

- Teacher's Orientation to Teaching Science (TOTS) questionnaire

The TOTS questionnaire is the Likert scale questionnaire composed of items which assess teachers' beliefs about goal of science teaching and the characteristics of teaching that support the goal.

- Classroom Observation Form

The Classroom Observation Form is used to collect data about learning activities, classroom environment, and classroom management of participating teachers that reflect the teacher's orientation to teaching science

3. Research method

The research methodology in this study was consisted of three main stages including research tool development, quantitative strand and qualitative strand. The purpose of this design is to combine the collection and analysis of both quantitative and qualitative data within a traditional quantitative research design (Creswell & Clark, 2011: 90).

Phase 1: Research tool development

- Teacher's Orientation to Teaching Science (TOTS) questionnaire was developed based on the conceptualization of Orientation toward science teaching proposed by Magnusson et al (2002) (see chapter 2). Then, the experts will examine the questionnaire in order to analyze content validity of the instrument. Then, the questionnaire was revised based on the experts. The questionnaire was tried out with 125 science teachers to conduct Rasch Model analysis with WINSTEPS version 3.57 computer programme. The Rasch measurement model was considered the most robust form of item response theory (IRT) available. Item response theory (IRT) modeled the relationship between a person's performance level on a single trait being measured by a survey instrument or test and the person's response to a survey or test item or question (Lord, 1980). According to Stocking (1997), item response theory made a strong assumption about a person's behavior when they responded to items. This was different from the classical test theory (or true score model) perspective. The advantages of item response theory according to Stocking (1997), were: (a) it was possible to characterize or describe an item, independent of any sample of people who might respond to the item, (b) it was possible to characterize a person independently of any sample of items administered to the person, and (c) it was possible to predict properties of a test in advance of test administration. Furthermore, Fox and Jones (1998) noted that Rasch analysis enabled researchers to: (a) test if the items formed a unidimensional variable, by examining statistically idiosyncratic responses, (b) calibrate the magnitude of differences between items and person on an interval scale, and (c) measure each person on a newly created variable on an interval scale. Since the questionnaire developed in this study employed rating scale categories, the

Rasch rating scale model was selected as an appropriate method to examine the data provided by the instrument. Wright and Masters (1982) argued that the Rasch model was appropriate for examining rating scales because the varying response options for the person and item scores could be obtained on the same logit scale and compared.

The Rasch rating scale model calibrates the summated test score into interval-scale score in log-odd or logits unit. Fox and Jones (1998) has expressed the probability of a person n responding to each Likert-type response category j for each item I, mathematically as shown in the following equation.

$$P_{nij} = f_n\left(\frac{exp(\beta_n - \delta_i - \tau_j}{1 + exp(\beta_n - \delta_i - \tau_j)}\right)$$

Where $\delta_{ij} = \delta_i + \tau_j$, n = subscript for persons, i = subscript for items, j = response categories (0,1,2,…j)

Rasch Model requires that the data fit to the model, that is, the degree of discrepancy between observed by the data and the expected by the model is kept to a reasonable level (Wright & Masters, 1982). In relation to this, the infit mean square (MNSQ) and outfit MNSQ provide indications of the discrepancies. The Rasch model provides two fit statistics, namely infit and outfit Mean Square Statistics (MNSQ). The infit MNSQ is sensitive to unexpected responses to items near the person ability level and the outfit MNSQ is outlier sensitive. Mean square fit statistics are defined such that the model-specified uniform value of randomness is 1.0 (Wright & Stone, 1979). Item fit indicates the extent to which a particular item is consistent with the way the sample respondents have responded to the other items. As such, a person with a greater ability has a higher probability of correctly answering any item and that an item of lesser difficulty has a greater probability of being answered correctly (Wright & Masters, 1982). Wright and Linacre (1994) have recommended the fit statistics ranges between 0.60 and 1.40 for mean squares and ±2.0 for standardized z-scores to indicate statistically significant item misfit. Fit statistics outside a literature-based established cut off values indicate a violation of expected response patterns which is central to Rasch measurement (Smith, 2004). On the other hand, the point-measure correlation is used to examine the extent to which the higher-valued responses to the items correlate positively with the person measures. Therefore, the positive values of correlations are expected. Rasch analysis also provides reliability indices for

both item and person measure. High reliability for both indices are desirable since they indicate a good replication if the comparable items or persons are employed.

In addition, the Rasch model software, WINSTEPS (Linacre & Wright, 1999) can graph person position with item position. Wright map shows simultaneous positioning of items and person responses illustrates where responses place each person with respect to those items. The Wright map is useful to determine the extent to which item positions match person positions. If the positions do not line up, the items are likely too easy or too hard to agree with, and to detect the gaps in the measure and further propose where items could be added.

In this study, each of the nine intended orientations were analyzed separately by inputting data from the six items that were intended to measure each individual orientation. The psychometric properties of the nine orientations underlying the Orientation towards Science Teaching scale were examined based on infit and outfit statistics indices, item and person reliability, and point-measure correlations. Wright map is used to determine whether the items of each needs to be further reviewed based on person ability. Prior to analysis, two important assumptions must be satisfied in Rasch rating scale model. First, the data must meet the unidimensionality assumption, that is, they represent a single construct (Wright & Masters, 1982). In WINSTEPS computer programme, the principal component analysis of the residuals procedure helps identify the existence of second factor that pose a threat to unidimensionality assumption. Secondly, items that are subjected to Rasch analysis are required to be independent of each other, indicating local independency must be met.

- Classroom Observation Form will be developed. The items in this form emphasize the classroom situation that is related to teacher's orientation to teaching science.

Phase 2: Quantitative strand

- The Teacher's Orientation to Teaching Science (TOTS) questionnaires were sent to schools all over both countries. The number of questionnaires were 500 for each country. The expectation of returned questionnaires for each country was 200. The result showed that 264 science teachers from Thailand and 167 science teachers from Malaysia sent the questionnaire back to the researchers.

- The results from the questionnaire were analyzed to find the highest agreement and trend of teachers' orientation to teaching science.

- 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.

Phase 3: 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 observe their classrooms and conducted an interview.

- Participating teachers responded to the TOTS questionnaire

- The researcher observed the participating teachers' classroom to collect data about classroom environment, learning activity and classroom management using the classroom observation form. Observations were analyzed by means of the observation form which contains nine orientations to teaching science.

- Teacher's interviews were conducted to collect data related to the rationale of participating teachers in choosing classroom activities. The semi-structured interviews were analyzed using content analysis.

- All data will be analyzed in order to examine how teacher's orientation toward teaching science is related to teaching practice.

Statistic and data analysis

One-way ANOVA was used to compare mean score of each group of orientations whether they are significantly different from each other. 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.