CHAPTER 1

Introduction

1.1 Principles and rationale

Physics demonstrations are often used in lectures to exhibit physics phenomena, to stimulate student interests and to make connection between physics principle and real experiments [1]. However, many studies provide strong evidence that students passively observing physics demonstrations gained conceptual understanding no different than those being taught with direct instruction [1, 2]. During "the traditional approach to demonstrations" [1, 3], most students often do not understand underlining concepts and incorrectly recalled what happened during the demonstrations [4].

Can student learn from demonstrations or laboratories? [4]. Many studies found that an active learning [5, 6] approach to demonstrations and laboratories helped student gain conceptual understanding [1, 2, 4, 7, 8, 9, 10] and promote long-term retention of knowledge [11]. Instead of note taking or passively observing, students have an opportunity to actively engage with the demonstrations by predicting and discussing possible outcomes of the demonstrations before observing it.

There are many research and efforts at introductory physics, but a few studies have been done with developing demonstrations and laboratories for advanced thermal physics courses. Our main goal is to develop demonstrations and laboratories that can be implemented actively, captures student interest and helps students to construct correct thermodynamic concepts.

1.2 Research Objectives

1.2.1 To develop thermodynamics demonstration including thermoelectric device (TEC), thermal physics of rubber band, and fog in the bottle

1.2.2 To evaluate student conceptions before and after teaching with the demonstrations by using Thermodynamics Conceptual Survey (TCS)

1.2.3 To implement model analysis in thermodynamics context

1.3 Usefulness of the Research

1.3.1 Thermodynamics demonstrations including thermoelectric device (TEC), thermodynamics of rubber band, and fog in the bottle for teaching introductory and advanced thermal physics will be obtained

1.3.2 Information of students 'thermodynamics conceptions before and after teaching with demonstrations will be gained

1.3.3 To implement model analysis in thermodynamics context

1.4 Structure of the Thesis

This thesis consists of eight chapters and the summary as shown in the following.

- **Chapter 1** is an introduction of this thesis, it contains: principles and rationale, research objectives, usefulness of the research, structure of the Thesis.
- **Chapter 2** is theoretical background, it contains the details of: student thinking model, methods for probing student thinking, two-tier multiple choice questions, model analysis, thermodynamics understanding, and interactive lecture demonstrations (ILDs).
- **Chapter 3** is the detail of Seebeck effect demonstration, it contains methodology, experimental design, experimental results and discussion, conclusion, and implementation to teaching.
- **Chapter 4** is the detail of thermodynamics of rubber band, it contains methodology, experimental design, experimental results and discussion, conclusion, and implementation to teaching.
- **Chapter 5** is the detail of fog in the bottle demonstration, it contains methodology, experimental design, experimental results and discussion, conclusion, and implementation to teaching.
- **Chapter 6** is the detail of physics education research methodology, it contains thermodynamics conceptual survey, model analysis, physics education for development of interactive lecture demonstrations (ILDs),

pee-pee boys demonstration, movable syringe demonstration, and physics education for evaluation of thermodynamics concept.

- **Chapter 7** is the detail of physics education results and discussion, it contains thermodynamics conceptual survey, physics education results for Seebeck effect demonstration, physics education results for thermodynamics of rubber band, physics education results for fog in the bottle demonstration, physics education results for pee-pee boys demonstration, physics education results for movable syringe demonstration, and physics education results for evaluation of thermodynamics concept.
- **Chapter 8** is conclusions and discussion of all these studies: thermodynamics conceptual survey, Seebeck effect demonstration, thermodynamics of rubber band, fog in the bottle demonstration, pee-pee boys demonstration, movable syringe demonstration, and physics education for evaluation thermodynamics concept.

An outline of eight chapters and the summary as shown in Figure 1.1.

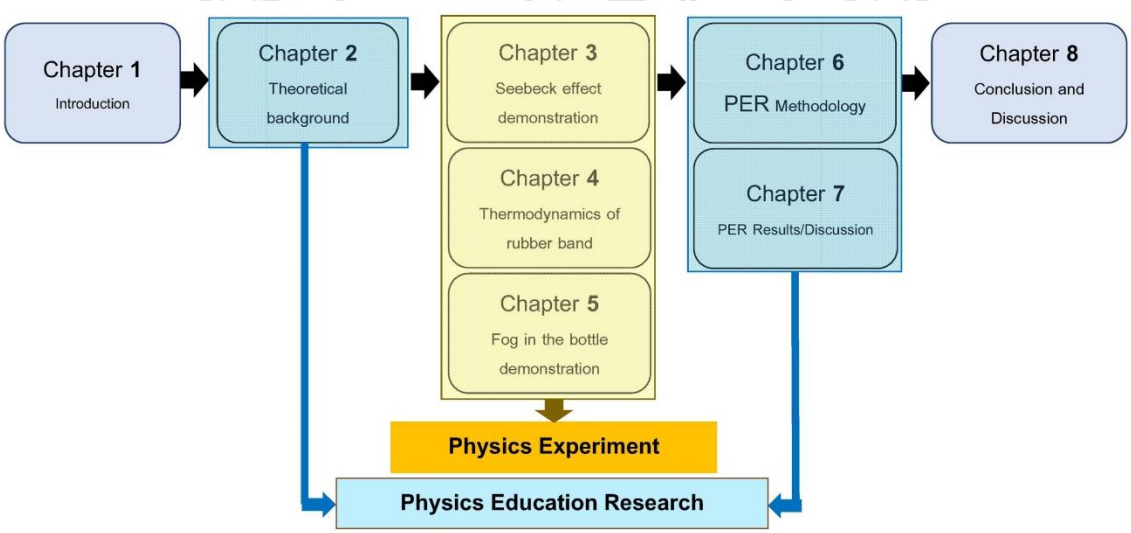

Figure 1.1 The outline of development and evaluation of teaching demonstration in thermal physics