

# Application of a Requirement Analysis Template to Lectures in a Higher Education Institution

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**Abstract.** Due to a declining population of 18-year-olds, higher education institutions are targeting new types of learners, such as adult learners who work full time while enrolled. To attract these new types of learners, higher education institutions need to provide education that takes account of the learners' requirements. To do so, this study evaluated education in higher education institutions from the viewpoint of learners. Specifically, we analyzed the requirements of learners using a requirement analysis template utilized in Service Engineering.

**Keywords:** Higher education, Customer requirement, Service Engineering.

## 1 Introduction

Recently, an aging society with a falling birth rate has caused the market to shrink. As a result, many service companies have been faced with seeking potential customers who were previously not their traditional targets. Higher education institutions have faced the same problem. Due to a declining population of 18-year-olds, higher education institutions are targeting new types of learners, such as adult learners who work in a full time job. However, higher education institutions do not necessarily provide education that satisfies the new types of learners. For example, they provide the same learning environment and tools to the new types of learners as they did to traditional students. To attract the new types of learners, higher education institutions need to provide education that takes account of the learners' requirements.

On the other hand, the authors of this paper conducted conceptual research on design services from the viewpoint of engineering. This series of research is called Service Engineering [1-3]. Its objective is to develop a fundamental understanding of services, as well as concrete engineering methodologies that can be used to design and evaluate services [1-3]. The value of a service is always perceived and determined by the customer: Providers can only offer value propositions [4]. Therefore, the design process proposed in Service Engineering includes procedures to understand a target customer and to extract his/her requirements. The functions and entities provided in the service are designed on the basis of these customer requirements.

From the viewpoint of services, learners in higher education institutions can be regarded as customers. Therefore, the education in higher education institutions needs to be designed and evaluated from the viewpoint of learners. To do so, this study aimed to develop methodology for designing and evaluating the education from the viewpoint of learners. Specifically, we analyzed the requirements of learners using the requirement analysis template [3] proposed in Service Engineering.

## 2 Approach of This Study

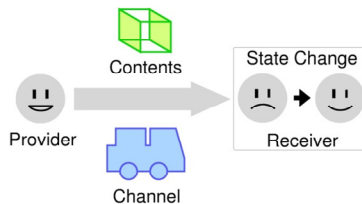
### 2.1 Overview

To attract the new types of learners in higher education institutions, this study assumes that the education in higher education institutions can be regarded as a service. Based on this assumption, the objective of this study is to develop a methodology for designing and evaluating the education from the viewpoint of learners. As the first step of this study, in this paper, we focus on a lecture where the learners correspond to customers and the teachers correspond to providers. The requirement analysis template [3] proposed in Service Engineering is applied to the lecture to analyze the requirements of the learners that are used as target parameters in designing and evaluating the education.

Section 2.2 presents an overview of Service Engineering, and Section 2.3 introduces the requirement analysis template.

### 2.2 Service Engineering

Service Engineering is a new engineering discipline with the objective of providing a fundamental understanding of services, as well as concrete engineering methodologies to design and evaluate services. In Service Engineering, the service is defined as an activity between a service provider and a service receiver to change the state of the receiver [1-3]. Note that the term “service” is used in a broad sense. Thus, the design target includes not only intangible human activities but also tangible products.



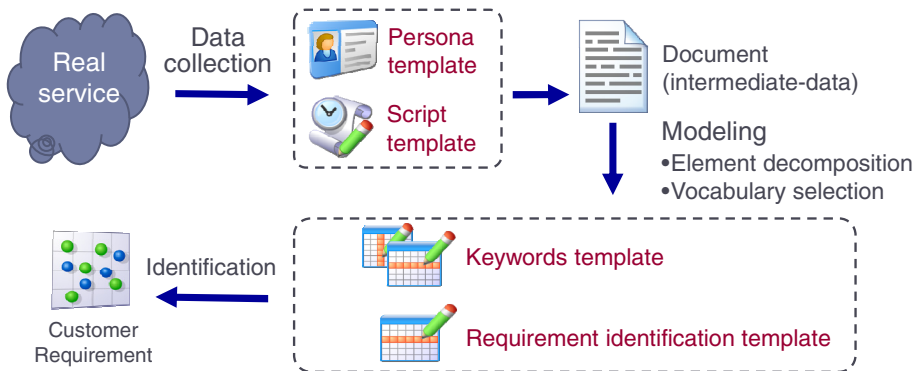
**Fig. 1.** Definition of a service [1-3]

According to the definition, a receiver is satisfied when his/her state changes to a new desirable state. Since the value of a service is determined by the receiver, service design should be based on the state change of the receiver. For design purposes, it is

necessary to find a method to express the state changes of the receiver. The target receiver's state in service design is represented as a set of parameters called receiver state parameters (RSPs) [1-3]. RSPs are changed by “service contents” and “service channels,” as shown in Fig. 1. Service contents are materials, energy, or information that directly changes the receiver's state. Service channels transfer, amplify, and control the service contents.

### 2.3 Requirement Analysis Template

The requirement analysis template was proposed to analyze the customer and to identify the requirements of a service [3]. This template enables designers to extract an exhaustive list of customer requirements and to provide objective evidence for the extraction of them.



**Fig. 2.** Overview of the requirement analysis template [3]

As shown in Fig. 2, the requirement analysis template consists of four kinds of template: a persona template, a script template, a keywords template, and a requirement identification template. The first step in the requirement analysis is identifying the target customer. For the identification of the customer, a concept called persona [5] is adopted to describe a representative customer in the form of personal information. The concept of persona is frequently used in the practical design of software interfaces. The persona is a tool that generates a simplified description of a customer and works as a compass in the design process. Based on the persona, a service script is described in consideration of the customer's activities in the service. The service script is written in natural language. Thus, it enables designers to analyze scenes where the customer is satisfied and/or dissatisfied. From the script, designers identify “keywords” that can be considered important elements for the service. Specifically, the script is decomposed into keywords from the viewpoint of the service phases and 4W1H: what, what like, how, where, and when. Finally, each keyword is associated with required items/qualities and quality elements using a predefined template and vocabulary list. Here, the “required items” refer to what customers want to do, and the “required quality” is a linguistic expression of

customer requirements related to the quality of the provided product/service. Namely, the required items/qualities indicate representations of “customer requirements” in the service. On the other hand, the quality elements are used as criteria for evaluating the quality. Ideally, the quality elements should be observable and controllable by designers.

### 3 Application

In this application, the requirement analysis template was applied to a lecture where students who correspond to learners conducted experiments of proportional integral derivative (PID) control. This lecture is geared toward students who major in mechanical engineering. The students learn the fundamental theory of (PID) control through modeling and control of a thermal system.

As the first step, a target student was identified by describing the persona shown in Fig. 3. The persona named “Koji Nemoto” is a 25-year-old Ph.D. student of mechanical engineering. As his personality, in this application, we described his behaviors and preferences.



#### **Basic information**

- Name: Koji Nemoto
- Age: 25 years
- Gender: Male
- Residential status:  
Lives alone

#### **Life style:**

- Lives in Hachioji-shi, Tokyo
- Ph.D. student, majoring in mechanical engineering
- Spends weekdays at the laboratory
- Interested in design engineering

#### **Personality:**

- He usually thinks a lot before he acts.
- He prefers lectures that contain active leaning rather than classroom lectures.
- His major is mechanical engineering, but he is NOT familiar with control engineering.
- He has learned a substantial amount of conceptual theory in his research. Therefore, it is easy for him to understand theories conceptually rather than mathematically.

**Fig. 3.** Persona template of the student in the lecture

Based on the persona, a service script was described in consideration of the student’s activities in the lecture. Fig. 4 shows an example of the script that describes a scene where he received an introduction to the theory used in this experiment and worked on a PID control experiment. This script includes not only how he behaved in the experiment but also what he thought and/or felt. For example, he felt “it was still unclear how the modeling worked in this experiment...” in the introduction to the modeling (see the underlined part in Fig. 4).

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### **Introduction to modeling**

- The teacher moved on to the introduction to modeling, and he asked the students “What is modeling.” I thought it was difficult to answer because the question was very abstract. I answered: “making a model, for example, a model plane, a model house, and so on”. He agreed with my answer and added that a model is one way of transferring and sharing information about an object in an objective and logical manner. His explanation clarified my understanding of the concept of modeling. However, it was still unclear how the modeling worked in this experiment...
- After explaining the concept of modeling, the teacher introduced the modeling of the thermal system used in this experiment. I did not understand the equation that represents the thermal system and the relationship between the equation and devices used in the experiment. He asked us to develop the transfer function by using the Laplace transform. I learned the Laplace transform when I was an undergraduate student, but I did not have clear memory of it. Following his instruction, I somehow managed to develop the transfer function...

### **PID control experiment**

- After the explanation of the theory of PID control, we began the experiment. In this experiment, we had to stabilize the temperature of water in an aquarium at 50 degrees Celsius using PID control. We measured the temperature of the water every minute. However, it was unclear how the PID control regulated the temperature. In addition, we calculated some parameters used in the PID control before the experiment. I did not understand how these parameters worked...
  - Finally, the temperature of the water was stabilized at 50 degrees Celsius. Based on the temperature data, we evaluated quality of controlling from the viewpoints of readiness, stability, and stationarity. I found it difficult to understand the evaluation criteria using only the explanation in the textbook, but the supplemental explanation that the teacher provided with illustrations made me understand more clearly...
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**Fig. 4.** Service scripts in the introduction of modeling and experiment of the PID control

From the script, we identified “keywords” that could be considered important elements for the lecture. As shown in Table 1, the script was decomposed into keywords from the viewpoint of the phases of the lecture and 4W1H. Instead of 4W1H, in this application, we adopted 3W1H: what, what like, how, and whom. For example, the action where the student measured the temperature of the water every minute was decomposed into: measure (action), temperature of the water (what), and every minute (what like).

**Table 1.** Keyword template in the introduction to modeling and the PID control experiment

Phases of service encounter	Action	What	What like	How	Whom
Introduction to modeling	Receive	Introduction to modeling		Oral presentation	
	Think	Abstract question about modeling	Difficult		
	Feel	How the modeling worked in this experiment	Unclear		
	Do not understand	Relationship between the equation and experiment devices			
	Think	Do not have a clear memory of the Laplace transform			
PID control experiment	Feel	How the PID control worked on the temperature	Unclear		
	Do not understand	How the calculated parameters worked			
	Feel	Understanding the evaluation criteria	Difficult	Textbook	

**Table 2.** Required items/qualities and quality elements in the PID control experiment

Keywords	Required items/qualities	Quality elements
Abstract question about modeling: difficult	- Receiving more concrete questions	- Concreteness of the question
How the modeling worked in this experiment: unclear	- Understanding of how the modeling works in this experiment	- Understanding of the role of the modeling in this experiment
Do not understand, the relationship between the equation and experiment devices	- Understanding the relationship between the equation and experiment devices	- Understanding of the relationship between the equation and the experiment devices
How the PID control worked on the temperature: unclear	- Understanding of how PID control works on the temperature	- Understanding of the role of the PID control
Do not understand, how the calculated parameters worked	- Understanding of how the calculated parameters worked	- Understanding of the role of the calculated parameters
Understanding of evaluation criteria: difficult	- Understanding of the evaluation criteria	- Understanding of the evaluation criteria

Finally, each keyword was associated with the required items/qualities and the quality elements, as shown in Table 2. For example, with regard to the keywords “How the modeling worked in this experiment” and “unclear,” “understanding how the modeling worked in this experiment” was extracted as a required item/quality in

the lecture. “Understanding of the role of the modeling in this experiment” was selected as a quality element that corresponds to an evaluation criterion for this required item/quality.

## 4 Discussion

To analyze the requirements of learners, in this application, a requirement analysis template was applied to a lecture where the students conducted a PID control experiment. The required items/qualities and quality elements were then extracted. For example, “understanding how the modeling worked in this experiment” was extracted as a required item/quality. To fulfill this requirement, the teacher could introduce the mechanism of the thermal system used in the experiment, and then model it step by step. This result is, therefore, useful for the teacher to improve his/her lecture from the viewpoint of the learners. In addition, the requirement analysis template was able to visualize the process for extracting the requirements of the learners. For example, the persona template can enable the teacher to understand the type of learners, such as his/her interests and research background; the service script can visualize contexts where students have certain requirements. The requirement template provides teachers with a greater understanding of students’ requirements than traditional methods, such as questionnaires.

In this application, we focused only on a certain type of student and then described the persona of that student. However, in an actual lecture, there are several types of student. The requirements of learners vary depending on their types, and it is difficult to fulfill these requirements in the format of a traditional lecture. Therefore, a method needs to be developed to customize the lecture for each student type. In addition, collecting data to describe the service script of each persona would place a heavy workload on the teacher. Therefore, a learning management system needs to be developed to collect such data efficiently.

## 5 Conclusion

This study aimed to design and evaluate the education in higher education institutions from the viewpoint of learners. As the first step of this study, in the application, a requirement analysis template was applied to a lecture where the students conducted a PID control experiment. The results revealed that the requirement analysis template is useful for the teacher to understand students’ requirements in more detail and to improve his/her lectures from the viewpoint of the learners.

Future work should include the development of a method to customize the lecture for each student type and a learning management system to collect the data for describing service scripts.

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