A Japanese Word Study Model for Chinese Learners by Using Petri Net

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Abstract: This paper proposes a Japanese word study model for Chinese learners by using Petri net. Firstly we classify Japanese words into several groups by considering Chinese learners' knowledge on Chinese characters. Then analyzing the difficulty levels of these word groups for Chinese learners to learn, we decide the studying order for these word groups. Based on these analytical results, we propose a Japanese word study model by using Petri net. Finally, we introduce an evaluation scheme to the proposed study model in order to evaluate learning effect of the learners.

1. Introduction

This paper aims at developing a Japanese e-learning [1] system for Chinese learners. As the first step, in this paper, we concentrate on Japansese word study and discuss how to construct the related system by utilizing the knowledge of Chinese characters that Chinese learners already have.

Generally, for word study of a foreign language, the following things must be considered: (i) to classify the words into different groups; (ii) to decide the study order of word groups; (iii) to decide learning times for the study of word formation, word meaning and word pronunciation; (iv) to develop evaluation method of the word study. There are several classifications of Japanese words for Japanese language learners and teachers [2][3], but, these classifications are formed on the basis of meaning and concept, and do not give consideration to connections with the native language. In this paper, we first analyze lexical similarities between Japanese and Chinese languages and then give the word study processes by considering the above (i)-(iv). moreover, we use Petri net[4] to model the word study process and passed on that we develop an evaluation scheme.

2. Brief Introduction to Petri nets

2.1 Definition of Petri net

Petri net is a powerful tool in modeling various concurrent systems and it has been widely applied to model systems' behaviors [4]. A Petri net is a bipartite digraph, which consists of two types of nodes, place and transition, and tokens expressing states of the Petri net and the condition for transition's firing. A firing of a transition move tokens from its input places to its output places to change the state of the Petri net.

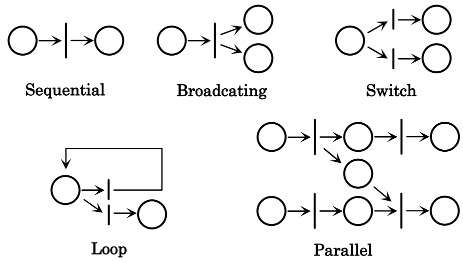


Fig.1 Five basic Petri net constructs

Petri net has five basic constructs (see Fig.1). They are (i) sequential, shows that two events are in sequential. (ii) broadcasting , one event causes the message being sent to more that two receivers. (iii) switch, the token at one place has choices to be moved to different places. (iv) loop, a action is repeating till a certain condition is not satisfied. (v) parallel, there are two or more events going concurrently, and may/may not communicate to each other.

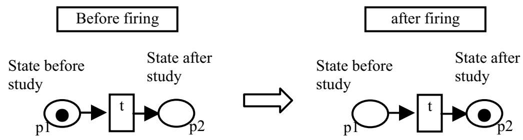


Fig.2 Action of Petri net

Figure 2 shows this basic action of Petri net.

In this paper, Petri net is used to model our study processes and based on that, we do simulation in order to evaluate efficiency of our system.

2.2 Why use Petri net to model e-learning system

Plan-Do-See, or PDS for short, is the classic process to construct a e-learning system. "Plan" is the first step to design the process. For the second step, "Do" means gethering and constructing all the contents. The third step "See", means verifing the study effect of this system. But in fact, we must repeat the second step and the third step till we get a satisfied result. That consumes a lot of resources and increases the cost.

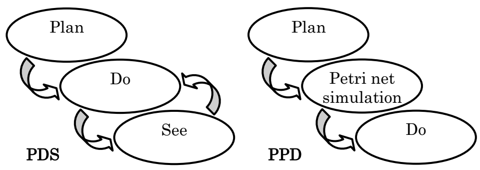


Fig.3 Constructing process of e-learning system

We plan to offer a new method named “PPD” for constructing e-learning (see Fig.3), the first “P” is “Plan”, just like “PDS”, the second “P” is “Petri net simulation”, and the “D” is “Do”. We replace “See” with “Petri net simulation”, using a computer simulation to check the study effect and the rationality of e-learning system presented by Petri net. With “PPD”, we expect to save a lot of time and resources and reduce the cost of e-learning system.

First of all, we must establish a Petri net study model.

3. A Japanese Word Study Model

3.1 Japanese word classification

Japanese words are composed by 3 elements: Kanji (Chinese character), Hiragana and Katakana. There are no regular rules which would allow Chinese learners to know how Japanese words are pronounced. Therefore, we will ignore this problem in this paper. But it is probably that knowledge of Chinese ideograms provides the Chinese learner with an important springboard for learning Japanese vocabulary, as ideograms Kanji were imported to Japan from various periods of China since the 5th century. So we classify Japanese words by using similarity between the meanings and formations of each ideogram in Chinese and Japanese.

In order to assess how much the Chinese learners can understand the meanings of Japanese Kanji, we conducted a survey on 130 Chinese college students who have never learned Japanese before. As a result, we found that Chinese students were able to understand at an average 78.3% Kanji based upon their similarity with their Chinese counterparts. This demonstrates that their knowledge of Chinese ideograms is helpful in learning Japansese. Based on this result, we attempted to classify Japanese words by their similarity to Chinese words upon two criteria: similarity of ideograph form, and similarity of meaning (see Table 1).

Table 1. A Japanese word classification

		Similarity of ideograms	Similarity of Meaning	Example (Chinese)
Group A	Same	✓	✓	電話(电话)
Group B	Self-same-1	×	✓	会う(见面)
	Self-same-2	✓	×	愛人(爱人)
Group C	Different	×	×	峠(山岭), くすぐったい(痒)
		Katakana loan words		カメラ(相机)

3.2 Study process

Language learners to study the second language usually adopt the process from what they think is easy to what they think is difficult. In order to assess the difficulty of each of the word classifications in Table 1 presented to the learner, we conducted a survey on 130 Chinese college students who have learned Japanese and found that, as expected, the difficulty of each classification varied as in Fig.4. Based on this result, we suppose that this order of groups is suitable for Chinese learners to study Japanese words.

Group A →Group B-1→Group B-2→Group C
easy← →difficult

Fig.4 Difficulty of new classification

The ideogram form, the meaning, and the pronunciation are necessary for studying vocabulary. Figure 5 shows the study processes for the learner who already has the knowledge of Hiragana and Katakana.

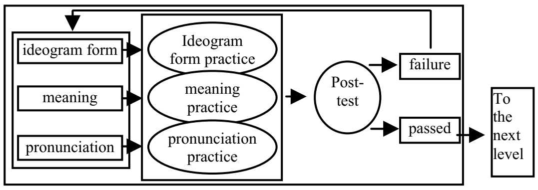
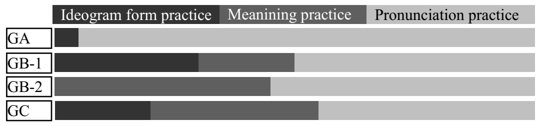


Fig.5 Study process

The greater the learner’s familiarity with Chinese ideograms, the less time they will need to learn ideographic forms (in groups A and B-2) or ideogram meaning (group A). Figure 6 shows the predicted amount of time required to learn the words in each of the 3 practice types.



G A: Same, G B-1: Self-same-1, G B-2: Self-same-2, G C: Different

Fig.6 Amount of each practice

In the next step, we need to assess how many problems will be used for these learning activities.

3.3 A proposal of Petri net model

We express Japanese word study processes by using Petri net according to Fig. 5. Figure 7 shows the Petri net model.

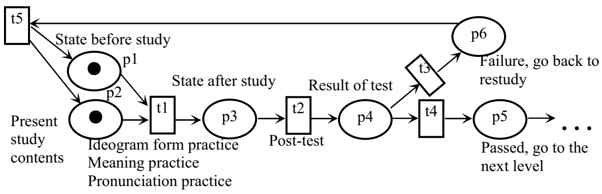


Fig.7 A Petri net model of study processes

In Fig.7, *p1* represents the state *before study*, and study process will start if *study contents p2* is provided. After study, we provide a *post-test t2* for testing the *study result p3*. After the test, learners are divided into *failure p6* or *passed p5*. The failure learners are forced to repeat studying until they reach state *p5*.

4. An Evaluation System

We try to divide the study objectives into 3 classes for judging the acquisition level, according to the students understanding over the three types of knowledge essential for language acquisition: knowledge of language formation, knowledge of pronunciation, and knowledge of meaning. The acquisition levels are: level 1 is a basic acquisition of the 3 knowledge types, level 2 is the ability to apply each knowledge type, and level 3 is the ability to apply all 3 knowledge types in a unified way (see Fig. 8).

In order to classify the acquisition objectives, we try to record the study history from the study processes as shown in Fig. 9.

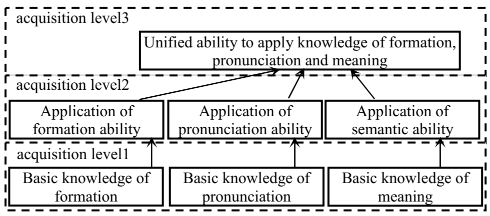


Fig.8 Three classes of acquisition objective

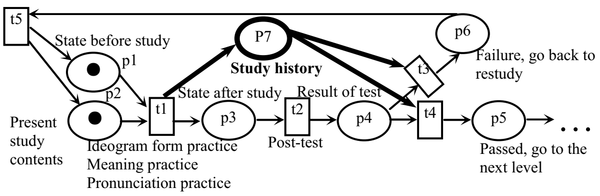


Fig.9 Petri net model with history collection

Study history may include (a) study time, (b) number of times being used, and (c) scores of the quizzes, etc. We regard these sub-histories as evaluation parameters, and use them to show the acquisition processes. For example, over a 20 minutes' study, a learner obtains scores of 50 on quizzes. Figure 10 shows a breakdown of the processes in this case.

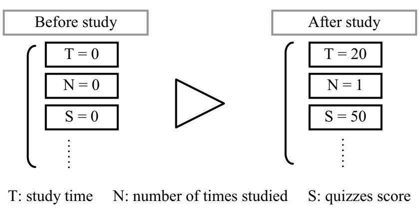


Fig.10 The transition of study history

In this way, we evaluate the study processes of acquisition levels using not only the final test scores, but also the histories as well as sub-histories of the scores tested during the study processes. Based on this, we can further divide the acquisition processes, and these subdivisions will be used to analyze and identify study problems.

For an example, we restrict the number of parameters to just verify the influence among time studied (T), diffculty of test or practice (D) , score of test (S) and number of times studied (N). From our experience, to learn the words of one lesson, it takes about 50mins. We set paramenter f(T)=0~1, where f(50)=1 and f(t) decreases as the time increases. Diffculty of test or practice is very complex, we don' t have enough datas to subdivide it, so we always assume f(D)=0.9 by now. Word study is the base of all the further study, we hope students to pass it with full score, that is parameter of full score 100/0.9=110 which should be set to 1. At the last, we add a pre-test to check kownledge related with concepts that students would learn. We try to calculate the efficiency of this model . Figure 11 shows this Petri net.

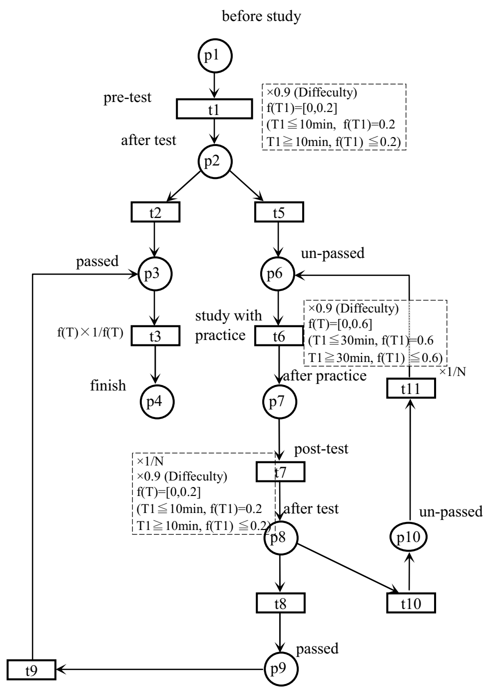


Fig.11 Petri net Study model with configured parameters

There is a student, he has to have a lot of practices to study the new words because he didn't pass the pre-test, that means he doesn't know anything about the new words. He also didn't pass the post-test of his first try after studing. Finally he passed it after he studied twice. All the data from the study process is just like that shown in Table 2.

Table 2. An assumption dates of study process

	Study Time (T)		Quizzes Score (S)		Number of Times Studied (N)
Pretest	T_0	9mins	S_0	50	2
First try	$T_{1.1}$	40mins	S_1	100	
Posttest of first try	$T_{1.2}$	20 mins			
Second try	$T_{2.1}$	20 mins	S_2	110	
Posttest of Second try	$T_{2.2}$	8mins			

Now, we try to calculate the study efficiency (E) of this student.

$$E=(f(T_0)\times 0.9\times S_0+(f(T_{1.1})+f(T_{1.2}))\times 0.9\times S_1\times 1/N+((f(T_{2.1})+f(T_{2.2}))\times 0.9\times S_2\times 1/N)/110$$

We substitute all the date for the expression above.

$$E=(0.2\times 0.9\times 50+(0.6\times 30/40+0.2\times 10/20)\times 0.9\times 100\times 1/2+(0.6+0.2)\times 0.9\times 110\times 1/2)/110$$

$$E=73.35/110=66.7\%$$

The study efficiency of this student is 66.7%. We need to notice that the study efficiency is not a score of test. In this case, this student's score is 110.

The reason why this score is low is that he studied twice and uses extra time. But, there are many more parameters (reasons) that can influence the study efficiency, we need to investiagte them furthermore. And we also must to make clear about the correspondence of a value of efficiency to the acquisition level classified in Fig. 8.

5. Conclusion

In this paper, we have proposed a way for Japanese word classification that is appropriate to Chinese learners, offered a Japanese word study processes and used Petri net to model the word study processes. This is the first step towards to develop a Japanese e-learning system for Chinese learner. As the future research, we need to (i) determine more parameters to complete the evaluation system, and to complete the entire Petri net model; (ii) do computational simulation to evaluate our model; (iii) realize Japanese e-learning system based on our Petri net model.

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