

*Research of Questions and Answers Judgment Technique to Develop 4R Risk  
Prediction Training System*

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0404

The Asian Conference on Technology in the Classroom 2013

Official Conference Proceedings 2013

Abstract

There are accidents which worker's lack of attention to a risk factor in cause of human factor.

Workers train to improve their risk prediction ability through 4R training method to prevent accidents by lack of risk prediction. The 4R method is learning method that the teacher judges worker's answers as right or wrong about risk which they indicate in the illustration shows in the work. The 4R method aims workers to improve imagination against risk by repetition of that workers find risk in the illustration shows in the work. However, there are some problems that workers cannot freely learn alone because there is a restriction which 4R method has to be done with their teacher and other worker.

Our research solves these problems to develop digital teacher in our 4R risk prediction training system which is able to substitute the human teacher in the conventional 4R method. The digital 4R training system helps workers learn spontaneously regardless of time or place even if there is no teacher. The 4R training system realizes same educational way with conventional method by it judges worker's answer as right or wrong instead of teacher.

In this paper, we propose the way to create content for the education and a method of natural language processing that is questions and answers to judge risk which a worker answered is correct. In addition, we report about the result of the evaluation experiment.

Research of questions and answers judgment technique to develop 4R risk prediction training system

## 1. Introduction

### 1.1 The current state of chemical plants

There are chemical plants that are dealing a large amount of chemicals and petroleum products. Those objects have dangerous with inflammability and explosion. Chemical plants are ran harsh environment under high temperature and high pressure for Efficiency of chemical reaction and stability maintenance of objects. Therefore, if an accident has occurred in a chemical plant, damage to businesses, serious environmental pollution, neighborhood facilities, local residents, workers and fatal accidents may be cause by an accident. It is important that an action is to prevent accidents and improve maintenance level for companies.

### 1.2 What is done in chemical plants?

It is necessity that risk prediction ability is to prediction and to accept against a risk for prevention accident. Director makes workers study education and experience for a risk in a virtual plant and filed exercise. Those purposes are to develop ability of a risk prediction in site. 4R training is generally development of thought for development ability of a risk prediction. This training can practice simplicity. In prediction training by 4R, a teacher show what are risks to workers against work. Next a teacher makes workers repeat risks and finger pointing and call. Thus a teacher makes workers take notice about risks.

### 1.3 Problem

4R lasts into 30-60 minutes to enforce. Therefore, it is reduced fifty-fifty five minutes. So it is not full for risk prediction training. Workers can't study alone because a director and workers must stay site. In addition workers practice similar works daily. It is difficult that a director always makes workers study new risk prediction training. And Training effect reduce [1] [2]. So far, 4R is stead to develop thinking power of countermeasure and to pick out risk for developing ability of a risk prediction. But it is a problem that 4R must be in good order environment.

### 1.4 Purpose of research • importance of system

In the present study, we propose a digital 4R training system to solve problems as previously noted. A director is changed a computer in 4R training. This solve problem that is necessary a director in previous 4R. In addition, this can solve problem of time and space. In this article, we report a procedure, a rule for the right or wrong to judge the answer by the free description of the trainer.

## 2. Digital 4R training system

### 2.1 flow of the training

We explain digital 4R training system in this section. The digital 4R training system shows a KYT seat like the 4R and is an education system that makes a trainer learned a risk. 4R is a kind of the risk prediction training [1]. The KYT sheet is the figure which expressed a state of the work that risk hides behind in. And we show the example of the figure in figure1. First, we show a KYT sheet and a problem sentence to a trainer.

Next, the trainer answers at the point where risk lies hidden in from a KYT sheet. Next, the trainer answers by a free description for a risk reason. Next, the digital 4R training system runs the right or wrong judgment for the answer of the trainer. Finally the digital 4R training system shows correct or incorrect to a trainer.

## 2.2 Design of the right or wrong judgment of the answer sentence

It is a correct answer or a non-correct answer or, by this system, must judge the answer by the freedom description of the trainer. We paid attention to the following item to realize the right or wrong judgment of the reply sentence mechanically.

### A) Comparison of having necessary word or not

We assumed a necessary word a word to be an opportunity to notice potential risk. And we thought that it was the most important word.

### B) Meaningful word

We thought that a risk reason, the thing such as the place were important in thinking about potential risk. We classified it in purpose object, cause (means, condition), damage point, four items of the predicate in a meaningful word.

#### I. explain predicate

The predicate is a verb to explain the movement of the meaning of the risk.

#### II. explain purpose object

The purpose object is a noun to cause the risk of the predicate

#### III. explain cause (means, condition)

The cause is a noun to become the cause to cause risk

#### IV. explain damage point

The damage point is a noun to show a part, the place that a worker injures.

### C) Characteristic in the construction

#### I. explain the number of end morphemes

We analyzed an answer sentence. And it is the number that showed the number of end morphemes from the analysis result.

### D) different notation synonym

Notation is different but different notation synonym is the same word meaning.

## 2.3 Technique procedure

We enforce right or wrong judgment for worker's reply sentences using a correct sentence.

We carry out the technique in a procedure of Step1 - Step9 as follows.

Step1: We prepare a KYT seat for training.

We prepared a KYT seat for training. We prepare the answer sentence (Sn) which I wrote down potential risk in Japanese for the risk of underlying n unit.

Step 2: We prepare verification data.

In this step we determinate verification data by section 2.2

In different notation synonym, it determined different notation synonym of the k joint of different notation synonym of the l unit for each predicate of

the m unit in the answer sentence Si We defined different notation synonym which synonym(Si, j, l),  $1 \leq i \leq n$ ,  $1 \leq j \leq m$ ,  $1 \leq k \leq l$ .

Step 3: we gobble down a reply sentence of trainer.

The trainer inputs a reply sentence, RS ,to explain potential risk. We analyze a reply sentence.

Step 4: we compare a correct sentence and reply answer.

From analysis result, we demand the number of morphemes of the correct sentence and the numerical difference of the numerical end morpheme of the morpheme of the reply sentence. We defined the number of end morphemes of the answer sentence as NMorpheme(Si). We defined the number of end morphemes of the reply sentence as NMorpheme(RSi). We defined the differences between NMorpheme(RSi) and NMorpheme(Si) as N. We defined AnsN as score of this step. We calculate mark AnsN of this item by difference N. We calculate a score according to formulas (1) here.

NMorpheme(Si) , it defined that  $1 \leq i \leq n$  refers. NMorpheme (Rsi) , it defined that  $1 \leq i \leq n$  refers.

$$N = | \text{NMorpheme}(Si) - \text{NMorpheme}(RSi) |$$

$$f(x) = \left. \begin{array}{l} N = 0, \quad \text{AnsN} = 30\text{points} \\ N = 1, \quad \text{AnsN} = 20\text{points} \\ N = 2, \quad \text{AnsN} = 10\text{points} \\ N = 3, \quad \text{AnsN} = 0\text{points} \end{array} \right\} \dots \text{formulas}(1)$$

Step 5: we check having necessary words or not.

From analysis result, we check whether a reply sentence contains necessary words. And we calculate score of necessary words according to formulas(2).

We define it as necessary word of the j joint of the answer sentence SI with the necessary word of the m unit. We defined the necessary word as NecessaryWord(Si,j). We define it as number of items EN (entry number) used by a necessary word, a meaningful word in an answer sentence. We define the number of required words of data for judgments included in the reply sentence as RNN (return necessary words number). We set Threshold with 70 this time.

$$\text{AnsNW} = \frac{\text{Threshold} \times \text{RNN}}{\text{EN} \times m} \dots \text{formulas}(2)$$

Step 6: I check having meaningful word or not.

A word used in a reply sentence compares it with each item in the meaningful word of data for judgments. And we check whether meaningful words of data for judgments are included in a reply sentence. We calculate the score of each item of the meaningful word according to formulas (3) ~ formulas (7).

We defined the score as AnsMW(MeaningWords). The predicate defines it as predicate meaningword.body(Si,j) of the j joint of the answer sentence having the predicate of the mb unit. The word of the item of the predicate in data for judgments defined the number of words included in the reply sentence as RMb (return meaning word.body number) in a predicate. The

purpose object defined it as  $\text{meaningword.object}(S_{i,j})$  targeted for the purpose of the  $j$  joint of the answer sentence having the purpose object of the  $m_o$  unit. The word of the item for the purpose in data for judgments defined the number of words as  $R_{M_o}$  (return meaning word.object number) in a reply sentence in a purpose object. The factor defined it as  $\text{cause meaningword.factor}(S_{i,j})$  of the  $j$  joint of the answer sentence with the factor of the  $m_f$  unit. The word of the item of the factor in data for judgments defined the number of words as  $R_{M_f}$  (return meaning word.factor number) in a reply sentence in a factor. I defined the damage point as  $\text{damage point meaningword.injure}(S_{i,j})$  of the  $j$  joint of the answer sentence to have a damage point of  $m_i$  toward. The word of the item of the damage point in data for judgments defined the number of words as  $R_{M_i}$  (return meaning word.injure number) in an reply sentence in a damage point. We defined the score of the item of the predicate as  $\text{AnsM}_b(\text{meaning word.body})$ . The score of the item where we are the factor  $\text{AnsM}_f$  (defined it as  $\text{meaningword.factor}$ .) We defined the score of the item of the damage point as  $\text{AnsM}_j(\text{meaning word.injure})$ .

$$\text{AnsM}_b = \frac{\text{Threshold} \times R_{M_b}}{EN \times m_b} \dots \text{formulas(3)}$$

$$\text{AnsM}_o = \frac{\text{Threshold} \times R_{M_o}}{EN \times m_o} \dots \text{formulas(4)}$$

$$\text{AnsM}_f = \frac{\text{Threshold} \times R_{M_f}}{EN \times m_f} \dots \text{formulas(5)}$$

$$\text{AnsM}_i = \frac{\text{Threshold} \times R_{M_i}}{EN \times m_i} \dots \text{formulas(6)}$$

$$\text{AnsM}_W = \text{AnsM}_b + \text{AnsM}_o + \text{AnsM}_f + \text{AnsM}_j \dots \text{formulas(7)}$$

Step 7: Different notation synonym processing

When there are words same as different notation synonym for a reply sentence, we assume that the words existed in the item of the predicate and calculate a score according to formulas (8). We defined the score of the item of different notation synonym as  $\text{AnsS}_w(\text{synonym.word})$ . We defined the number of words included in the reply sentence as  $R_{S_w}$  (return synonym.word number) in different notation synonym.  $M$  in formulas (8) is the number of words in data for judgments of the predicate.

$$\text{AnsS}_w = \frac{\text{Threshold} \times R_{S_w}}{EN \times m} \dots \text{formulas(8)}$$

Step 8: Calculation of the right or wrong judgment score

We assume the result that we added the score that I found by Step3~8 to the final score

If final scores are more than 70 points, we assume a reply sentence as correct.

If final scores are less than 70 points, we assume it to be incorrect.

$$FS = \text{AnsN} + \text{AnsNW} + \text{AnsMW} + \text{AnsS}_w \dots \text{formulas(9)}$$

Step9: Search end judgment

It finishes a right or wrong judgment.

### 3. Evaluation experiment

This chapter, we evaluated the right or wrong judgment performance of a correct sentence and the reply sentence that we proposed in this article.

### 3.1 evaluating method

In this evaluation experiment, we prepared a correct sentence and some reply sentence of workers for figure 2. figure 2 is a KYT seat. And we conduct subjected right or wrong judgment for those sentences.

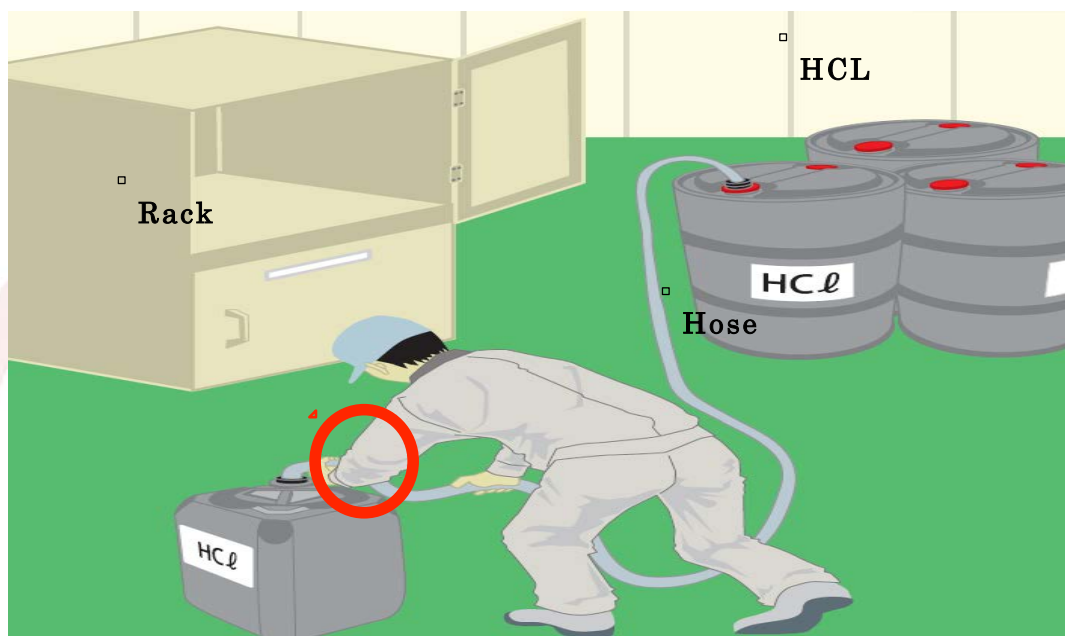


Figure 1 : A KYT seat

Problem sentence for figure 2 was “you are restocking a tank with HCL. Please the point of the circle answer for a risk reason”. We set out a correct sentence. A correct sentence was “a worker injures hands by HCL”. We set out necessary words and meaningful words by 2.2 sections before we analyze reply sentences of workers. We wrote down the result in the row of the correct sentence of table 1. And if there were synonyms, we wrote down the row of the synonyms of table 1. This time we prepared 5 sentences of reply sentences of workers.

The First reply sentence was “HCL attaches to hands, and the worker injures hands.

The second reply sentence was “the worker gets on HCL to hands and injures”.

The third reply sentence was “the worker cut s hands on the lid”.

The fourth reply sentence was “HCL is dangerous”.

The fifth reply sentence was “HCL hangs in worker’s hands”.

We calculated a score according to a procedure of the technique and, using the item which we decided for a reply sentence, carried out a right or wrong judgment to refer a score to reply sentence ①～⑤. We show the result in Table 1. 1 showed that correct sentence words were included the reply sentence. 2 showed that correct sentence words were not included the reply sentence. The row of final score in Table 1 showed final score of reply sentences. And the row of the result of right or wrong judgment in Table 1 showed right or wrong.

Table 1 ; experiment result

		Correct sentence	Reply sentence ①	reply sentence ②	reply sentence ③	reply sentence ④	reply sentence ⑤
necessary word							
meaning word	Meaning word body	Injure	A	A	B	B	B
	meaning word object	HCL	A	A	B	A	A
	Meaning word factor						
	Meaning word injure	hands	A	A	A	B	A
Characteristic in the construction		3	3	3	2	1	2
Synonym		Get hurt, injure					
Final score			100	100	43.3	33.3	66.3
Result of right or wrong judgment			right	right	wrong	wrong	wrong

#### 4. Result

We prepared 4-5 answer sentences for 14 correct sentences. And we subjected right or wrong judgment for them like 2.2 section. In addition, we researched whether contradiction occurred between the result of the right or wrong judgment and the meaning of the sentence. We show the result in table 2. In table 2, A shows that contradiction does not occur between the meaning of the sentence like the result of the right or wrong judgment. B shows that contradiction occurs between the meanings of the sentence with the result of the right or wrong judgment. So B calculated correct in the right or wrong judgment but incorrect semantically.

Table 2 : result of right or wrong judgment

	reply sentence①	reply sentence②	reply sentence③	reply sentence④	reply sentence⑤
correct sentence①	A	A	A	A	A
correct sentence②	A	A	A	A	
correct sentence③	B	B	A	A	A
correct sentence④	A	A	A	A	
correct sentence⑤	A	A	A	A	
correct sentence⑥	A	A	A	A	
correct sentence⑦	A	A	A	A	A
correct sentence⑧	A	A	A	A	
correct sentence⑨	B	B	A	A	A
correct sentence⑩	A	A	A	B	
correct sentence⑪	A	A	A	A	
correct sentence⑫	A	A	A	A	A
correct sentence⑬	A	A	A	A	
correct sentence⑭	A	A	A	A	

5. conclusion

In this paper, we refer to a digital 4R training system for convenience improvement of 4R. In addition, we propose that a digital 4R training system is questions and answers judgment technique. We confirmed that 8B% of correct answers rate were caught. But we confirmed this evaluation result by hand working. We construct questions and answers judgment system in future. And we evaluate its performance

6. Reference documents

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The logo for the International Association for Future-Oriented Research (iafor) is centered on the page. It consists of the lowercase letters "iafor" in a light blue, sans-serif font. The text is enclosed within a circular frame formed by two thick, curved lines. The upper line is light blue and the lower line is light red, both with a soft, feathered edge. The overall design is minimalist and modern.



