Self-Directed Learning Evaluation Using Fuzzy Grade Sheets

Kwang-Baek Kim, *Member, KIMICS*, **Byung-Joo Kim** and **Jae-Hyun Cho**, *Nonmember*

Abstract—This paper is about the use of existing evaluation methods, which evaluate learning determined by the score of an exam, which is either a multiple-choice type or single choice type question. These scores don't show the objective evaluations that cause some negative opinions about the scores. In this paper, we propose that the evaluation of the methods of self-directed learning use the triangle-type function of the fuzzy theory so that the learner can objectively evaluate their own learning ability. The proposed method classifies the result of learning into three fuzzy grades to calculate membership, and evaluate the result of an exam according to the final fuzzy grade degree as applied to the fuzzy grade sheets.

Index Terms—Self-directed Learning, Learning Ability, Fuzzy Grade Sheets

I. INTRODUCTION

Nowadays, the world is changing faster than ever in every single area of our lives. To adapt to this world, the ability to solving problems by oneself is a very necessary skill.

Finding problems and solving problems by oneself, becomes a necessary skill because other people are not always available to help. The purpose of education is not only to deliver the knowledge, but to also teach how knowledge can be acquired. In order to do this the procedure of a quest and of solving problems is important because human knowledge is temporal.

The evaluation method of self-directed learning gives the initiative to each individual so they can plan how to learn, how to find the necessary information, how to search the data, and how to evaluate learning [1]. In existing evaluation methods, the evaluation of learning is determined by the score of an exam, which is either a multiple-choice type or single choice type question [2]. The method of self-directed learning using the Web (WWW) doesn't show the objective evaluations that cause some negative opinions about the evaluation. Therefore, this paper proposes using the evaluation method of self-directed learning which uses the fuzzy theory where by the learner objectively evaluates his/her own learning ability. The proposed method classifies the result of learning into three fuzzy grades to calculate membership, and evaluates the result of an exam according to the final fuzzy grade degree as determined by the fuzzy grade sheets.

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II. CONCEPT AND FEATURE OF SELF-DIRECTED LEARNING

The general idea of self-directed learning is a procedure where an individual recognizes the necessity of learning, making a plan, searching the data, selecting the best method, and then learning and evaluating without any help from others. In self-directed learning, the individual must use their initiative and active participation is needed instead of a passive attitude. Everyone who has a strong motive and actively participates will improve his or her ratio of accomplishment. Self-directed learning has some special features. In this system, a learner has the ability to find and solve problems. The design for learning is important in improving ones ability to solve problems and develops originality in thinking.

III. EVALUATION METHOD OF SELF-DIRECTED LEARNING USING FUZZY THEORY

In this paper, we propose a method of self-directed evaluation using the triangle-type membership function of the fuzzy theory.

A. Triangle-type membership function design

Membership function is the main element of the fuzzy set. According to these results, several types of membership functions are proposed [3,4]. In general, because the fuzzy set is used to represent personal subjectivity in spite of personal difference, which represents a linguistic value, we need to use a standard for comparison of the persons. From this point of view, when we deal with the fuzzy set, it is convenient to use the standard parameter membership function with a changeable parameter. In this paper, we will apply a triangle-type membership function based on the standardized parametric membership functions. Figure 1 represents the triangle-type membership function. In this figure, x is the input value, $\mu(x)$ is the membership grade of x. The x has a membership grade in the interval $[x_L, x_H]$. If x is equal to x_M, the membership grade is one. Therefore, in the interval $[x_L, x_H]$, input value x is decided as followings [5,6,7,8].

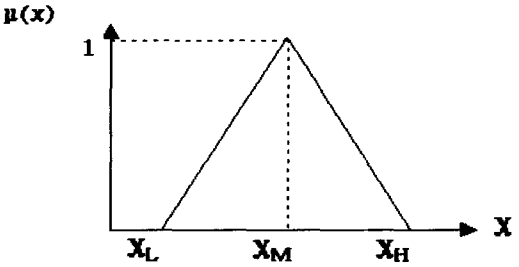

Fig. 1 Triangle-type membership function

if $(x \le X_L)$ or $(x \ge X_H)$ then $\mu(x) = 0$
if $(x > x_M)$ then $\mu(x) = (x_H - x) / (x_H - x_M)$
if $(x < x_M)$ then $\mu(x) = (x - x_L) / (x_M - x_L)$
if $(x = x_M)$ then $\mu(x) = 1$

B. Membership function on the number of response to learning

The membership function on the number of response to learning is organized into C_{HC}, C_{MC}, C_{LC} as Table 1.

Table 1 Parameters of the fuzzy membership function on the number of response to learning

Fuzzy Parameter	Fuzzy Value	Fuzzy Interval
C_{Hc}	Count $_{H\_much}$	[8, 14]
C_{Mc}	Count $_{M\_common}$	[4, 10]
C_{Lc}	Count $_{L\_little}$	[0, 6]

C_{LC} has a high fuzzy membership degree on the number of response to learning and has an interval [0,6]. When the number of learning is 3, membership degree is 1. In Figure 2, the membership of C_{Lc} is computed as follows: The membership function of the number of response to learning can be shown as Figure 2.

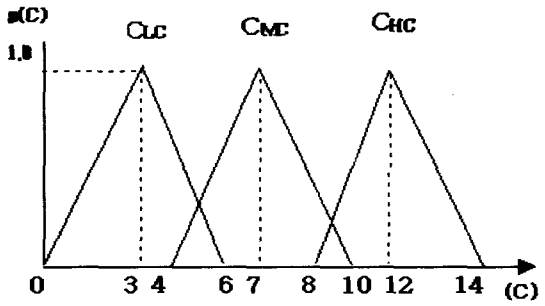

Fig. 2 Membership function on the number of response to learning

If $(C \le 0)$ or $(C \ge 6)$ then $\mu(C) = 0$
Else if $(C > 3)$ then $\mu(C) = (6 - C) / (6 - 3)$
Else if $(C < 6)$ then $\mu(C) = (C - 0) / (3 - 0)$
Else $(C = 3)$ then $\mu(C) = 1$

C. Membership function on the test evaluation

The examination's problems of information process engineering are organized into four examples. To evaluate the learning ability of organized problems, the membership function is applied. The pivot is the total mean value and is computed with the number of responses to learning, which are the previous mean value, and the present mean value. The following equation (1) is shown in the above method. In this equation, I is the total number of response to learning, M is the previous mean value, K is the present mean value, and TM is the total mean value. The previous mean value (M) means the mean value of previous problem's evaluation on a test evaluation and the present mean value (K) means the mean value of the present problem evaluation. Therefore, we decided that the fuzzy grade sheets on learning ability use the total mean value.

$$TM = (M + K) / I \quad (1)$$

Table 2 is shown as the membership function on learning ability evaluation. This is organized into three fuzzy values (T_{HS}, T_{MS}, T_{LS}). T_{HS} has a high value and interval of [6, 10] for the evaluation of the test. The membership of T_{HS} is computed as following in Figure 3.

If $(T \le 6)$ or $(T \ge 10)$ then $\mu(T) = 0$
Else if $(T > 8)$ then $\mu(T) = (10 - T) / (10 - 8)$
Else if $(T < 8)$ then $\mu(T) = (T - 6) / (8 - 6)$
Else $(T = 8)$ then $\mu(T) = 1$

Table 2 Parameter of the fuzzy membership function on learning ability evaluation

Fuzzy Parameter	Fuzzy Value	Membership Interval
T_{HS}	Test $_{High\ Degree}$	[6, 10]
T_{MS}	Test $_{Middle\ Degree}$	[3, 7]
T_{LS}	Test $_{Low\ Degree}$	[0, 4]

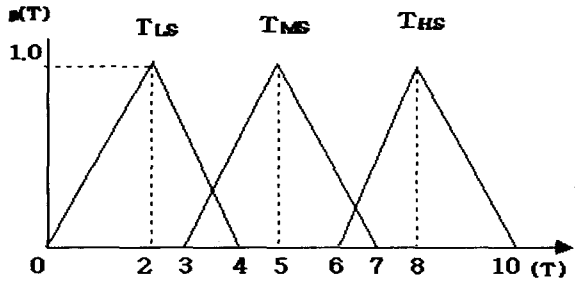

Fig. 3 Fuzzy membership function on test evaluation

D. Fuzzy grade sheets

In general, the evaluation may include a subjective evaluation on evaluation statements and it is not to be trusted. Therefore, this paper proposes a method for objectively, trustfully, and fairly obtaining an evaluation by using the fuzzy grade sheets.

1) Fuzzy grade sheets on learning ability evaluation

The grade of the fuzzy scores is evaluated as follows. S (F,M) is used to represent the similarity of two fuzzy scores and is computed as an equation (2).

$$S(F, M) = (F \bullet M) / \max(F \bullet F, M \bullet M) \quad (2)$$

In this equation, F represents the standard scores (α, β, γ, δ, ε) of the fuzzy grade sheets, M is a fuzzy score on the learning ability evaluation of any learner. When we define A, B that fuzzy set of universal set X, operation of A•B can be defined as equation (3). Then, it is defined as U satisfying the following conditions using the total mean value TM, the grade of fuzzy score M is shown as equation (4).

$$A \bullet B = \sum (\mu_A(x_i) \bullet \mu_B(x_i)) \quad (3)$$

$$S(U, M) = \max\{S(\alpha, M), S(\beta, M), S(\gamma, M), S(\delta, M), S(\varepsilon, M)\} \quad (4)$$

Therefore, the fuzzy grade sheets on evaluation about learning ability can be evaluated as the evaluation fields as shown in Table 3.

Table 3 Fuzzy grade sheets on evaluation about learning ability

Apply Number	Fuzzy Score			Total Mean (TM)	Grade
	M1	M2	... M6		
Count 1					
Count 2					
• • •					

In above fuzzy grade sheets, the results of twice learning ability's evaluation, fuzzy scores and evaluation of the grade is as follows.

[Procedure 1]
M1 = { 0, 0, 0.6, 0.8, 0.6, 0.6} Total : 2.6
Count1 = Max{ S(α, M1), S(β, M1), S(γ, M1), S(δ, M1), S(ε, M1)}
[Procedure 2]
M2 = {0, 0.8, 0.7, 0.5, 0.4, 0.2} Total: 2.6
Count2 = Max{ S(α, M2), S(β, M2), S(γ, M2), S(δ, M2), S(ε, M2)}
[Output] Count1 = S(γ, M1) = 0.7(γ),
Count2 = S(β, M2) = 0.9(β)

According to the fuzzy grade sheets, a grade can be produced in spite of the equal total score and we can't conclude that it is equal to the fuzzy grade of learning ability. Therefore, the proposed method classifies grades using the fuzzy grade sheets.

IV. EXPERIMENTAL RESULTS

A. Design of the Database in Web environments

This paper's database is composed by the administration, learner, and contents of problems using Personal Oracle 8i. Table 4, 5 and 6 represents structures of the schema.

Table 4 Problem table SQL structure

```
Create table question(
    no number primary key,
    ctt varchar2(1000) not null,
    ex1 varchar2(1000) not null,
    ex2 varchar2(1000) not null,
    ex3 varchar2(1000) not null,
    ex4 varchar2(1000) not null,
    res varchar2(1000) not null,
    cmt varchar2(1000) not null);
```

Table 5 Administrator table SQL structure

```
Create table manager (
        id      varchar2(15)  primary key,
        pswd    varchar2(15));
```

Table 6 User table SQL structure

```
Create table userinfo (
        id          varchar2(15)  primary key,
        pswd        varchar2(15),
        email       varchar2(40),
        avg         number,
        count       number  default  0,
        att_int     number,
        att_str     varchar2(20),
        first_login date    default  sysdate,
        last_login  date);
```

B. Information Management of Administration, Learner in Web

The administrator will register problems according to abilities of learning on the Web. The registered problems are evaluated as solved by the learners on the Web. Figure 4 represent the screen of the administration's problem registration. This paper computes the evaluation of learning ability by using JAVA as the reading database information, which is connected by JDBC in Web. Figure 5 represents the structure of the learning ability evaluation.

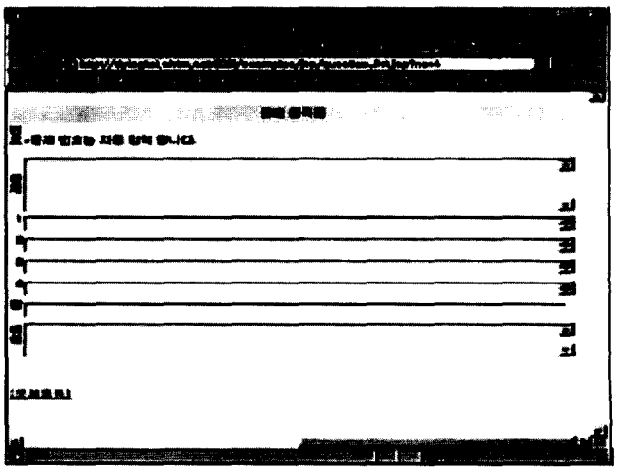

Fig. 4 Administrator's problem register in Web

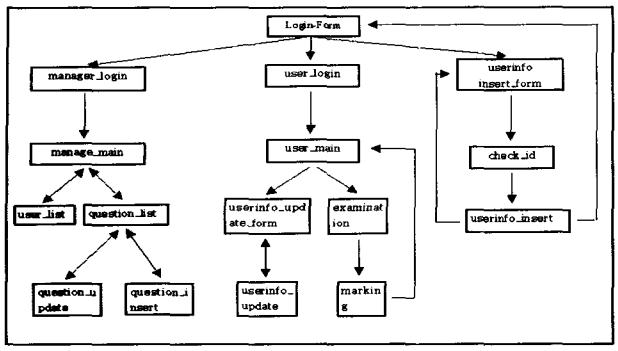

Fig. 5 Structure of learning ability's evaluation

C. Computation of learning ability's evaluation in Web

Figure 6 represents the screen of results on the learning ability evaluation of the learner. This screen displays the numbers of applied tests, correctness, incorrectness, unsolved problems and previous mean value. The total mean value is computed by the number of apply and previous mean value. The computed total means value can be given a grade according to grade sheets using the fuzzy membership function. Figure 7 represents a screen of the results on learning ability evaluation of the total learners. We can compare it with the previous and total mean value in figure 7. Because the results of the fuzzy grade are classified as a different grade among learners having same total mean value, we have objectively classified the learning ability evaluation of the test score.

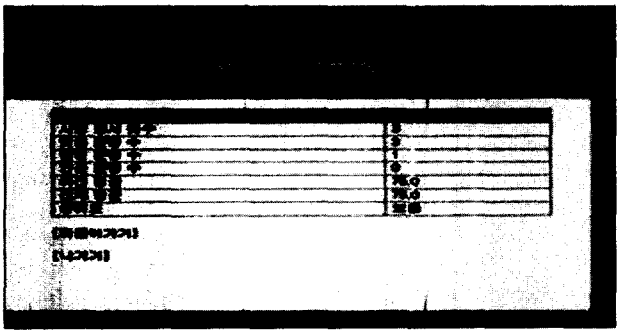

Fig.6 Example of evaluation result about learning ability

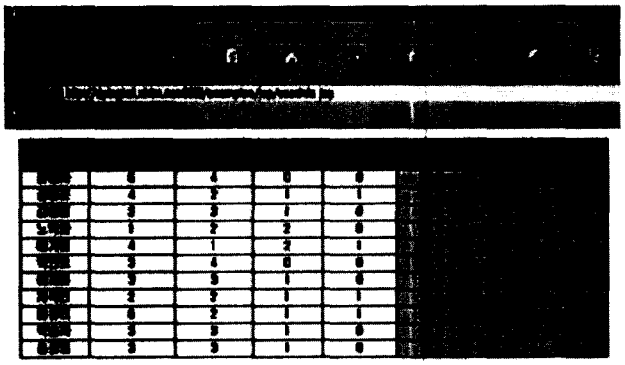

Fig.7 Results on learning ability's evaluation of total learner

D. Implementation of Interface in Web

Implementation of the learning ability evaluation is composed by the learner and the administration's display in web. After we confirm a learner by using the database's registered information, the learning ability evaluation is computed from the test problems. Figure 8 represents the screen of user confirmation in the database. Figure 9 shows the result of registration in the database.

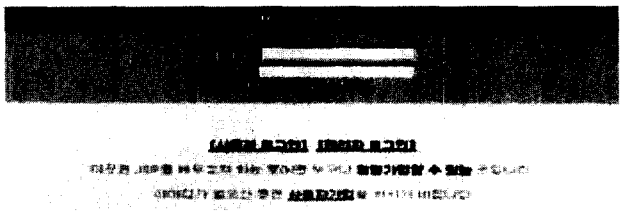

Fig. 8 User confirmation procedure

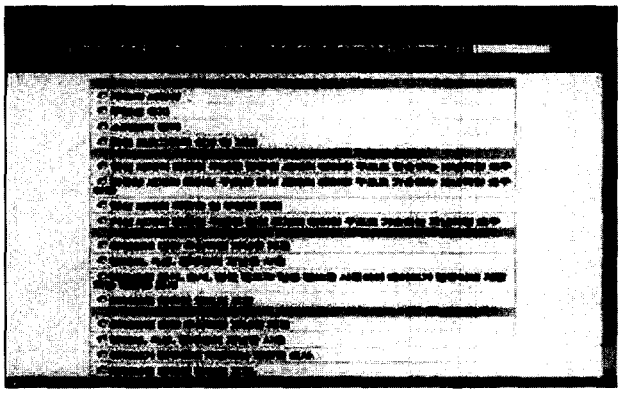

Fig. 9 Registered problem in database

V. CONCLUSIONS

In this paper, we proposed a method of self-directed learning evaluation, which uses the triangle-type membership function and the fuzzy grade for the self-directed learning evaluation. In the proposed self-directed learning evaluation method, the total mean value is computed by the number of applied tests and previous mean value. After the computed total mean value is applied in the membership function, it is classified according to the fuzzy grade. According to the fuzzy grade sheets, in cases where there are the same total score and a different grade, we classify the fuzzy grade of the learning ability evaluation. Therefore, we have objectively evaluated the learning of the learner by eliminating the learner's subjectivity. In the future, we will research topics where we will statistically analyze the efficiency of learning using several applied learning contents.

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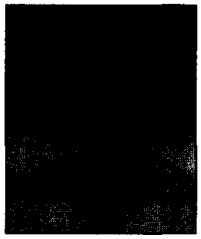

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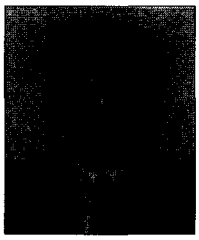

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