

## **A FUZZY EVALUATION MODEL FOR MONITORING THE ENGLISH HUMAN CAPITAL**

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*ABSTRACT: English has been an international language as the globalization waves spread overwhelmingly. Many EFL countries have invested a lot of budget in enhancing their human capital. How to examine their achievement becomes an important reviewing work. In this paper we utilize fuzzy statistical analysis and fuzzy evaluation to measure the English human capital from input and output. The former includes teachers' and students' efforts, while the latter consists of students' achievement. We propose a fuzzy model for monitoring the English human capital. From the empirical study, we can see that Korea possess better English human capital than others.*

**Keywords:** Fuzzy Evaluation Model; Human Capital; Efficiency

**1. Introduction.** In order to develop English education, many countries, such as Korea, Japan, and Taiwan, conducted educational reform and embedded English curriculum in the elementary schools. By increasing the learning hours or years, the policy makers hope that the citizens' English ability can be improved (Chang, 2009). The assurance and monitor on education quality is an issue that all the educators or policy makers can not neglect (OECD, 2010). Recently, several international organizations have conducted multinational achievement test to evaluate the education quality among the worldwide countries, for instances, PISA by OECD and TIMSS by IEA. These indicators and results for education quality not only offer a picture for each country to examine the internal development of education system, but also set up a cross-country comparative mechanism and chance. By doing so, the participant countries can have objective and in-depth understanding toward their educational development (OECD, 2007). However, the current large multinational achievement test for students, such as PISA, PIRLS, and TIMSS, focus on reading, math, and science. Foreign language is not included in the program.

Comparing to the high value and promotion toward English education among English as foreign language (EFL) countries, the educational authorities and researchers paid few attentions on instruments and methods about how to evaluate the performance. Hence, it's necessary to develop an evaluation mechanism or model for the English human capital.

In addition to practical learning achievements, stakeholders of English educations play critical roles. In other words, it may be of great meaning if we take teachers' and students' perception or expectation toward English learning into consideration.

According to the above, the purposes of this study include: 1.Utilize fuzzy statistics to discover English human capital from perceptions of secondary teachers and students; 2.Discuss the differences among various student backgrounds; 3.Establish evaluation model of English human capital at country level and do a multinational comparison.

## 2. Literature Review

**2.1. Educational Evaluation.** Education is an enterprise that needs great amount of investments and may have profound and lasting effects on students. If the educational investments lack the quality it should be, the country will face two dangerous consequences. One is the waste of the budgets; the other is the decline of its national power. In order to understand the effects of educational investment, we can't ignore the issues about how to conduct education evaluation in a effective and efficient way. As Scriven has mentioned in 2001, evaluation can be used in rational conversation and policy making. He continued that tremendous influence would be found in distributing resources, improving life needs, developing evaluation techniques, accessing to the wealth, and even the investment and education. Stufflebeam(2003) also indicated that evaluation is the statements, access, provision and application process of advantages and descriptive and judgmental information for certain goal, design, conduct, and outcomes. The main function is to act as the guidelines for improving decision making. Besides, evaluation contains other functions, such as providing accountability report, institutionalizing informed system, and sending orders.

With regard to the form of education evaluation, Stufflebeam & Shinknfield (1985) concluded all of the evaluations in terms of pseudo-evaluation, quasi-evaluation, and true evaluation based on the thirty criteria developed by the Joint Committee on Standard for Educational Evaluation in 1981. The first category includes covert investigations and public relations-inspired studies. The second category consists of objectives-based studies and experimentally oriented studies. The third category contains decision-oriented studies, client-centered studies, policy studies, and consumer-oriented studies.

As for the objects of education evaluation, there are personnel evaluation and program evaluation. The former includes the critical roles in educational industry, for instance, student evaluation, teacher evaluation, principal evaluation and so on. The latter involves a series of activities for discovering and evaluating toward the target program (Pan, 2005).

**2.2. Human Capital.** Human capital refers to people invest themselves by means of education and vocational training to enhance personal capability and accumulate more wealth (Becker, 1964). Human capital can be viewed as stock of knowledge that people own to solve problems, create performance, and value for the organizations (Bontis, Crossan, & Hulland, 2002). In the era of knowledge economy, human capital particularly plays a vital role on the up and down of a country's economic trend. Hence, it is how much human capital can be cultivated, attracted, and preserved that act as the critical elements for

the success of an organization or the development of a country (Stark, Helmenstein and Prskawetz, 1998; O'Neill, 2001)

We can roughly divide the researches on human capital into four subcategories. The first focuses on human capital and organizational performance (Teuke, 2001; Zemke, 2001). This dimension proclaims that the more human capital an organization have, the more positive influence it causes on organizational performance. Thus, the major objective is to maintain and invest human capital to assure the progressing performance. The second category concerns about the relationship between overall manpower structure and economic growth of a country (Gardiner, 1998; O'Neill, 2001). They suggest that the indicators, such as average educational level and literacy rate, have much to do with economic growth. The third dimension aims at the development of human capital in the government (Force, 2001; Voinovich, 2001), whereas the fourth category is devoted to discuss how to evaluate human capital in a effective and efficient way (Berkowitz, 2001; Libert, 2001).

According to the discussion in the above, education and training represent the investment of human capital, and lead to the improvement of manpower quality which is beneficial to personal and the country. If the premise is true, it is of significance for any EFL country that wants to enhance its English competitiveness to discover how much the overall English human capital it has. Therefore, the study makes efforts to propose a possible model to investigate English human capital.

### 3. Research Methods

**3.1. Evaluating English Human Capital from Teachers' and Students' Point of View.** In the study, we intended to establish an evaluation model that can deal with the English human capital in EFL countries. The evaluation process of the model involves five major parts: goal, subjects, contents, method, and EHC review. To begin with, since the purpose of this study aims at the EFL countries in East Asia, the target countries are Japan, Korea, and Taiwan. As for the evaluation subjects, we collect data that represent internal performance from teacher's and students' perspective. The evaluation contents consist of content areas and individual competences. The content areas include listening, speaking, reading, writing, and cultural learning, whereas individual competences possess teacher instruction, students' ability, student's motivation, and learning strategies four subcategories. Concerning the evaluation method, the first step is to calculate expected performance by means of several functional formulas that embedded in teachers' and students' fuzzy language expression. The so called fuzzy language expression represent the input, namely teachers' and students' efforts on English. The next step is to conduct the computing so as to get a property value of a single country. The value refers to how well the human capital a country possess. Then we compare with the values and determine the sequence of efficiency among the three countries. Finally, the study provides strategies for improving the English education efficiency in the future. The flowchart for the evaluation process described in the above is showed in Figure 1.

The study adopts TOEIC score as the reference to students' achievement. To describe the expected students' achievement, we utilize the functional formula to form an expected TOEIC score. With regard to the real students' achievement, we link it to the mean score of the target country published by ETS in 2008.

We assume TOEIC score as reference framework because of the five criteria. Firstly, TOEIC test has serious theory background and evaluation development mechanism. Secondly, the TOEIC test has features of business and applied trend. Thirdly, it has been admitted by a lot of nations, organizations, companies, and institutions. Fourthly, it also widely accepted in geographical regions. Above all, TOEIC test is friendlier than other international English proficiency tests because of its low charge for the testees, which in turn may attract more people to take part in the test.

**3.2. Why We Use Fuzzy Evaluation.** Fuzzy theory is generated by Zadeh in 1965. He utilizes fuzzy logic as the foundation to extend the concepts of traditional math's binary logic. To begin with, the theory defines attribute as a set, and then develop related concepts that include attribute set, attribute space, and measurable space. Furthermore, fuzzy theory builds up the measure space based on the measurable space from the point view in math.

The attribute statistics is completely different from traditional probability statistics in terms of logical conception and frameworks. We provide an example for clear illustration and present the results in Table1. Let  $X$  be the population of the samples that describes  $X = \{ \text{English teacher} \}$ , and  $\chi$  refers to samples in certain area and time. If we want to study a specific feature within  $X$ , we define the feature as attribute space  $F$ . In this example, we consider the universe set  $X = \{ \text{English teacher} \}$ , one of the element in  $X$  is  $x$ , and defined as some professional development, let membership set of  $X$ ,  $F = \{ \text{English professional knowledge of culture} \}$ , the cut of  $F$  set  $\{C_1, C_2, C_3, C_4\} = \{ \text{English culture, English children literature, English drama \& movie, Internationalization education} \}$ . Either  $C_1$  or  $C_2$  is one the conditions in  $F$ , therefore, we can view  $C_1$  or  $C_2$  as attribute set that belongs to  $F$ 's subset.

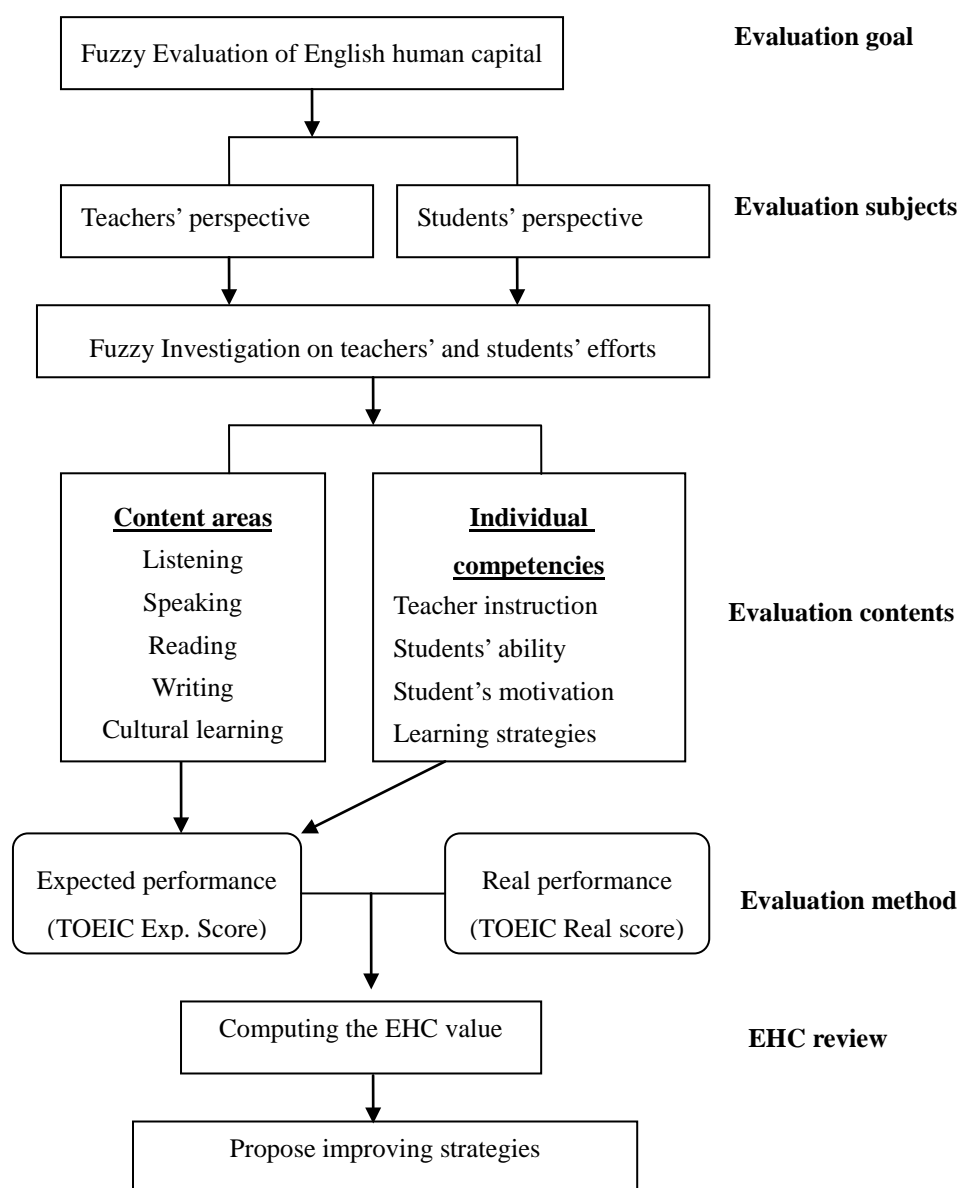


FIGURE 1. Flowchart for the evaluation process

TABLE 1. Culture requirement for EFL teachers

	Traditional Culture	Children literature	Drama and Movies	International view
EFL Teacher		0.5	0.2	0.3

In traditional statistics, mean score is presented by point, so it's called point estimation. However, in fuzzy statistics, the data are fuzzy intervals. We use interval to display the centralized trend of data. The arithmetic ideas are based on related definitions of traditional statistics. On the other hand, for the same subject, the value obtained by

traditional questionnaire must be included in the fuzzy interval that obtained by fuzzy questionnaire of the same question. Therefore, these two kinds of data to some extent possess correlation. Related concepts of fuzzy statistics using in this paper are illustrated as follows:

**Definition 3.1 Fuzzy sample mean (data with multiple values):** Let  $U$  be the universal set (a discussion domain),  $L = \{L_1, L_2, \dots, L_k\}$  be a set of  $k$ -linguistic variables on  $U$ , and

$\{Fx_i = \frac{m_{i1}}{L_1} + \frac{m_{i2}}{L_2} + \dots + \frac{m_{ik}}{L_k}, i=1,2,\dots,n\}$  be a sequence of random fuzzy sample on  $U$ ,

$m_{ij}(\sum_{j=1}^k m_{ij} = 1)$  is the memberships with respect to  $L_j$ . Then, the Fuzzy sample mean is defined as

$$F\bar{X} = \frac{\frac{1}{n} \sum_{i=1}^n m_{i1}}{L_1} + \frac{\frac{1}{n} \sum_{i=1}^n m_{i2}}{L_2} + \dots + \frac{\frac{1}{n} \sum_{i=1}^n m_{ik}}{L_k}$$

**Definition 3.2 Fuzzy weight (FW):** We consider universe of discourse  $S = \{S_1, S_2, \dots, S_k\}$ , utility sequence  $r_1 \prec r_2 \prec \dots \prec r_f$ , and  $S_i$  in  $r_f$  membership is  $\mu_{s_i f}$ .

Then the Fuzzy weight  $FW = (FW_{s_1}, \dots, FW_{s_k})$  is defined as:

$$FW_{s_i} = \frac{\sum_{l=1}^f \mu_{s_i l}}{r_l} = \frac{\mu_{s_i 1}}{r_1} + \frac{\mu_{s_i 2}}{r_2} + \dots + \frac{\mu_{s_i f}}{r_f}; i=1, \dots, c.$$

In the fuzzy set, membership ranges from 0 to 1, and every language variable, such as shape, represents a possible distribution. The results of the distribution might be different from different subjects. We can average the answers from the subjects to make the utility sequence  $r$  of universe of discourse  $S$  membership  $\mu_s$  reasonable distribution (Wu, 2005).

**Definition 3.3 Fuzzy relative weight analysis:** If we consider utility sequence  $r = \{r_1, r_2, \dots, r_f\}$ , then define  $r_1 \prec r_2 \prec \dots \prec r_f$  as utility increasing sequence; otherwise,  $r_1 \succ r_2 \succ \dots \succ r_f$  is utility decreasing sequence.

According to the sort of utility sequence, the computing of the fuzzy relative weight is: Consider universe of discourse  $S = \{S_1, S_2, \dots, S_k\}$ , utility sequence  $r = \{r_1, r_2, \dots, r_f\}$ , and  $\mu_{s_i f}$  is the membership of  $r_f$  in  $S_i$ . Then the fuzzy weight for element of universe of discourse  $FW = \{FWS_1, \dots, FWS_k\}$  is defined as

$$FW_{s_i} = \sum_{l=1}^f \mu_{s_i l} / r_l = \mu_{s_i 1} / r_1 + \mu_{s_i 2} / r_2 + \dots + \mu_{s_i f} / r_f; i=1, \dots, c$$

Testing hypothesis of homogeneity for interval fuzzy samples:

(1) Sample: Let  $\Omega$  be a discussion domain,  $\{L_j, j=1, \dots, k\}$  be ordered linguistic variables on the total range of  $\Omega$ , and  $\{a_i = [a_{li}, a_{ui}], i=1, \dots, m\}$  and  $\{b_i = [b_{li}, b_{ui}], i=1, \dots, n\}$  and are random fuzzy sample from population A, B with standardized membership function  $mA_{ij}, mB_{ij}$ .

(2) Hypothesis: Two populations A, B have the same distribution ratio. i.e.  $H_0: F\mu_A = F\mu_B$ ,

where 
$$F\mu_A = \frac{\frac{1}{m}MA_1}{L_1} + \frac{\frac{1}{m}MA_2}{L_2} + \dots + \frac{\frac{1}{m}MA_k}{L_k} \quad F\mu_B = \frac{\frac{1}{n}MB_1}{L_1} + \frac{\frac{1}{n}MB_2}{L_2} + \dots + \frac{\frac{1}{n}MB_k}{L_k} ,$$

$$MA_j = \sum_{i=1}^m mA_{ij}, MB_j = \sum_{i=1}^n mB_{ij} .$$

(3) Statistics :  $\chi^2 = \sum_{i \in A, B} \sum_{j=1}^c \frac{([Mi_j] - e_{ij})^2}{e_{ij}}$ . ( In order to perform the Chi-square test for fuzzy data, we transfer the decimal fractions of  $Mi_j$  in each cell of fuzzy category into the integer  $Mi_j$  by counting 0.5 or higher fractions as 1 and discard the rest.)

(4) Decision rule : under significance level  $\alpha$ , if  $\chi^2 > \chi_\alpha^2(k-1)$ , then we reject  $H_0$ .

### 3.3. Integrated Fuzzy Evaluation Process.

Step 1. Collecting the students' and teachers' data from the three countries. We also set up the weight.  $FW_{s_i} = \frac{\sum_{l=1}^f \mu_{s_i l}}{r_i} = \frac{\mu_{s_i 1}}{r_1} + \frac{\mu_{s_i 2}}{r_2} + \dots + \frac{\mu_{s_i f}}{r_f}; i = 1, \dots, c.$

Step 2. Computing the expected score. Let  $P_{S_i}^m$  be the  $i$ th student's expected value on the  $m$  item.  $X_i$  be the English achievement for the  $i$ th students at the  $j$  country.

$$X_i = \sqrt{\frac{\sum_{k=1}^{T_n} P_{T_i}^m}{T_n}} \times \sqrt{\frac{\sum_{k=1}^{S_n} P_{S_i}^m}{S_n}} \quad k = 1, \dots, T_n/S_n \quad m = 1, \dots, 5$$

Exp Score =  $\log(X_i) \times 890 + 100$  the expected English mean score of the  $i$ th country.

Step 3. Computing Efficiency of Expected Performance (EEP)

EEP =  $\log(1 + Rs/EpS)$ , where  $Rs$  = real score,  $EpS$  = Expected score

Step 4. Efficiency of Real Performance (ERP)

ERP =  $\log(1 + Rs/GM)$ ,  $GM$  = Global mean

Step 5. Integrated efficiency evaluation

$$EHC = EEP + ERP$$

**4. Empirical Studies.** In the study, we adopt questionnaire survey and fuzzy language computing to establish an evaluation model of English education for the EFL countries. The subjects are students and English teachers of secondary schools in Japan, Korea, and Taiwan. The total samples of teachers were 54, whereas 38 of them were valid. The return rate was 70%. As for the student samples, the total amount is 90 and the valid samples were 59. The return rate was 65.5%. Among the valid teacher samples, we received 12, 14, and 12 from Japan, Korea, and Taiwan respectively. With respect to student samples, the number is 15, 14, and 30 from Japan, Korea, and Taiwan respectively. Hence, the study meets Gay's suggestion that the required amount of subjects in a quantitative study should be no less than thirty samples (Gay, 1992).

**4.1. Differences Analysis Of Individual Competences.** The Kruskal-Wallis analyses of individual competences data are summarized in Table 2. The differences lie in the four

categories among the three countries; hence, we conduct Mann-Whitney U 2-Group Comparison Tests. Korea and Taiwan express significantly higher than Japan in Teacher instruction and students' ability, whereas no significance between Korea and Taiwan. As for motivation and learning strategies, Korea is significantly higher than Taiwan and Japan. When compares Taiwan with Japan, the differences occurred in motivation solely, not in learning strategies.

TABLE 2. Summary of kruskal-wallis one-way analysis of variance for ranks to test for differences in individual competences

	Countries				
	Japan(n=15)	Korea(n=14)	Taiwan(n=30)		
	Rank average	Rank average	Rank average	$\chi^2$	P
Teaching	11.77	40.57	34.18	24.074	.000***
Competence	15.90	35.57	34.45	13.637	.001***
Motivation	15.23	47.93	29.02	26.684	.000***
Learning strategies	22.43	44.71	26.92	14.260	.001***

TABLE 3. Summary of mann-whitney u 2-group comparison tests of individual competences to determine which countries differed

	Countries	Japan (n=15)	Korea (n=14)	Taiwan (n=30)	U	Z	P
Teaching	J-K	8.80	21.64		12.000	-4.109	.000***
	J-T	10.97		29.02	44.500	-4.359	.000***
	K-T		26.43	20.67	155.000	-1.387	.165
Competence	J-K	11.00	19.29		45.000	-2.651	.008***
	J-T	12.90		28.05	73.500	-3.658	.000***
	K-T		23.79	21.90	192.000	-.454	.650
Motivation	J-K	8.53	21.93		8.000	-4.360	.000***
	J-T	14.70		27.15	100.500	-3.027	.002***
	K-T		33.50	17.37	56.000	-3.884	.000***
Learning strategies	J-K	8.47	22.00		7.000	-4.413	.000***
	J-T	21.97		23.52	209.500	-.376	.707
	K-T		30.21	18.90	102.000	-2.724	.006***

**4.2. Differences analysis of background variables.** The study includes four background variables, which are school area, students' sex, tendency to study English, and expectation to do English-related jobs. The discussion can be divided into two parts.

As shown in Table 4, the Mann-Whitney U 2-group comparison tests have indicated that



school area leads to significant differences in students' ability ( $U=232.5$ ,  $p < 0.01$ ). Students' ability in urban schools ( $RA=34.72$ ) is higher than those in rural ( $RA=22.07$ ). The tendency to study English results in significant differences in teacher instruction ( $U=178$ ,  $p < 0.01$ ) and learning strategies ( $U=223.5$ ,  $p < 0.05$ ). These reveal that students with high tendency to study English ( $RA=40.38$ ) respond better to effectiveness of teacher instruction than those with lower tendency ( $RA=26.14$ ). When comparing personal learning strategies, students with high tendency to study English ( $RA=37.53$ ) score higher than the other group ( $RA=27.20$ ). It seems that English education attract specific group of audiences. In other words, implementing English education only looks after partial students. The other background variables, such as gender and expectation to do English-related jobs, don't show any difference in individual competences.

TABLE 4. Summary of Mann-Whitney U 2-Group Comparison  
Tests of background variables on Individual Competences

		Rank average	Rank average	U	Z	P	
School area	Teaching	32.12	26.43	328.5	-1.233	.218	1=Urban (n=37) 2=Rural (n=22)
	Competence	34.72	22.07	232.5	-2.739	.006**	
	Motivation	33.05	24.86	294.0	-1.779	.075	
	Learning strategies	31.19	28.00	363.0	-.692	.489	
Sex	Teaching	31.82	28.12	380.5	-.828	.408	1=Male (n=30) 2=Female (n=29)
	Competence	32.45	27.47	361.5	-1.116	.264	
	Motivation	31.37	28.59	394.0	-.624	.532	
	Learning strategies	26.87	33.24	341.0	-1.431	.153	
Expectation to study English	Teaching	40.38	26.14	178.0	-2.835	.005**	1=Willing (n=16) 2=Unwilling (n=43)
	Competence	35.38	28.00	258.0	-1.468	.142	
	Motivation	37.00	27.40	232.0	-1.918	.055	
	Learning strategies	37.53	27.20	223.5	-2.062	.039*	
Do English- related jobs	Teaching	33.22	24.59	288.0	-1.869	.062	1=Willing (n=37) 2=Unwilling (n=22)
	Competence	31.73	27.09	343.0	-1.005	.315	
	Motivation	33.28	24.48	285.5	-1.913	.056	
	Learning strategies	32.39	25.98	318.5	-1.392	.164	

**4.3. Comparing the Performance of EHC among Japan, Korea, and Taiwan.** How can we predict the results of English human capital of a country? Table 5 illustrates the comparison among Japan, Korea, and Taiwan. As shown in the first row, the sequential order of the expected score is Korea, Taiwan, and Japan. Korea scores higher than Taiwan

and Japan with the amount of eleven and fifty-three respectively, whereas Japan falls behind Taiwan for forty-two. As for the real score in 2009, Korea outperforms its expected score for fifty-seven while Japan and Taiwan do not perform greatly better or worse than their expected score.

If we compute the formula to build up Efficiency of Expected Performance (EEP), the results present 0.30, 0.32, 0.30 for Japan, Korea, and Taiwan respectively. In the former discussion, Taiwan has a higher expected score than Japan. Why do the two countries have the same EEP value? The reason may contribute to the EEP function is depended on the result of subtracting from expected and real score, namely the “distance” between real and expected TOEIC test score. Although the expected score of Japan is much lower than that of Taiwan, the real score is close to what it has been expected. In other words, the “distance” between real and expected score is almost the same between Japan and Taiwan. Therefore, the two countries possess the same EEP value.

TABLE 5. The comparison of Efficiency among Japan, Korea , and Taiwan

	Japan	Korea	Taiwan	
Expected score	502	555	544	Korea > Taiwan > Japan
Real score ( 2009 )	508	612	539	
EEP	0.30	0.32	0.30	Korea > Taiwan = Japan
ERP	0.28	0.32	0.29	Korea > Taiwan > Japan
EHC=EEP+ERP	0.58	0.64	0.59	Korea > Taiwan > Japan

According to the common sense, the students’ score is the higher the better. This judgment can be partially correct. In the study, we implement a “relative” perspective to discover the performance of English education. That’s the significance of ERP. ERP represents the “distance” from the real performance of a single country to the global mean score. On the one hand, the higher real score a country performs the better performance it has. On the other hand, the lower it scores the worse real performance it owns. If we simply consider the “distance” between country and global mean score to describe the efficiency of a country, we may encounter an indistinguishable phenomenon. For instance, two countries that have twenty marks higher and lower than global mean respectively maybe get the completely the same value of ERP. For this reason, we have modified the formula to exclude the error possibility. As displayed in Table 4.4, the sequential order of ERP is Korea (0.32), Taiwan (0.29), and Japan (0.28).

As we define the EHC is the sum of EEP and ERP, we can take a closer look at the last row in Table 4.4. The EHC of Korea is the highest (0.64), followed by Taiwan (0.59) and Japan (0.58). Hence, the EHC in Korea is superior to that in Taiwan and Japan.

**5. Conclusion.** The study aims to evaluate English human capital by means of fuzzy method, discover discrepancies from background variables, and establish an evaluating model at country level to conduct a multinational comparison. According to the empirical analysis, Korea stores the most EHC than Taiwan and Japan.

Japan has the fewest EHC among the three countries. It should improve students’

learning motivation and learning strategies. For Korea, its advantages lie in teacher instruction, students' ability, learning strategies, and motivation. Despite of the advantages in teacher instruction and students' ability, Taiwan should enhance their students' learning strategies and motivation. Both teachers and students express higher membership than the average. This phenomenon means that they pay lots of efforts on English teaching and learning. However, there are discrepancies between the countries. The stake holders of English education ought to examine the possible effective factors to facilitate English learning from policy, curriculum and instruction, and learning.

Discrepancies from background variables are found in terms of school area, expectation to study English, and do English-related jobs. Students who expect to study English may possess positive perceptions towards effectiveness of teacher instruction, learning strategies, and motivation. Those who are willing to do English-related jobs have higher motivation in general.

To increase the EHC, we offer some possible solutions or implications. 1. Establish a multinational cooperation system to conduct performance evaluation and monitor the quality of English education. 2. The government and academic institutes can collaborate with each other to build up multiple English learning context and pipelines to make up the gap between urban and rural area. 3. Keep strengthening in-service and pre-service teacher education can be the ground of human capital for suitable and multiple English curricula. 4. Teachers can develop extensive and applied English curricula and activities to enhance students' learning motivation and strategies. Above all, each country should assemble all the possible resources to set up the universality and accessibility of English in real life contexts in respond to the requests of the global era.

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