Applications of Correlation Coefficients of Hesitant Fuzzy Linguistic Term Sets to Assess Educational Quality of Curriculum Base on Educational Quality Assurance in Higher Education

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Abstract

The research aimed to 1) study the new method in scoring for the process indicators of the internal educational quality assurance in high education using correlation coefficients of hesitant fuzzy linguistic term sets, 2) compare the assessment score on educational quality of curriculums in the Faculty of Science, Ubon Ratchathani Rajabhat University according to the process indicators of the internal education quality assurance in higher education between correlation coefficients of hesitant fuzzy linguistic term sets application and traditional method in scoring. Twenty four participant experts appointed by the Higher Education Commission, were selected by purposive sampling. Research instrument were self-assessment reports of eight curriculums in the Faculty of Science of Ubon Rachathani Rajabhat University and evaluation forms. Statistics used in data analysis were the correlation coefficients of hesitant fuzzy linguistic term sets and mode. The method consisted of the followings: 1) creating a hesitant fuzzy linguistic term sets to explain the criteria of the scores of each indicator; 2) creating a hesitant fuzzy linguistic term sets to explain the experts' opinions that used to evaluate the educational quality of each indicator; 3) finding the correlation coefficients value between the sets in 1 and 2; 4) interpreting the correlation coefficients and a maximum value of correlation coefficients would be a determinant of the score for each indicator. The study found that the score of each indicators of each curriculum were equivalent to 0 and 1, which was lower than the mode of the educational quality evaluation.

Keywords: Hesitant Fuzzy Linguistic Term Sets, Correlation Coefficients, Educational Quality Assurance

Introduction

The mission to be implemented by the University consist of producing graduates, doing research, giving the academic services to social and preserve arts and culture. The mission in question to the country development both in short and long term. The education assurance in higher education is essential to promoting an efficiency. The qualitative education assurance include an internal quality assurance system and an external quality assurance system. Both are used as a mechanism to uphold the quality and standards of higher education institutions. The internal quality assurance system is used to develop, monitor and evaluate performance of higher educational institutions according to policy, goals and standard quality. The agencies and educational institutions require the quality assurance system and treat the system as part of the education administration process. Thus it is important and necessary for the educational institution to carry out the internal quality assurance on a yearly basis. Besides, the reports on the quality assurance are to be made accessible to the public. (Office of the Higher Education Commission, 2014)

In 2014, the office of the higher education commission, having realized the importance of the higher education in producing the graduates, had established the guidelines for the internal quality assurance system. The system comprises three level: curriculum, faculty and institute. An evaluation process is based on a peer review, which includes three experts whose duty is to provide recommendations for further development in line with the set criteria. (Office of the Higher Education Commission, 2014)

There are six components and fourteen indicators for an internal education assurance of a curriculum in higher education. The indicator 1.1: curriculum management pertains a curriculum control in accordance with the standard criteria. The other indicators are divided into two types: outcome indicators and process indicators. The process indicators are composed of indicator 3.1: admission, indicators 3.2: promotion and development of students, indicator 3.3: effect on students, indicator 4.1: management and development of teachers, indicator 4.3: effect on teachers, indicator 5.1: substance of subject, indicator 5.2: teacher system and teaching process, indicator 5.3: student evaluation and indicator 6.1: learning support. The evaluation criteria for each indicator are as follows:

Table 1 The evaluation criteria for indicator 3.1, 3.2, 4.1, 5.1, 5.2, 5.3 and 6.1

score	process
0	No system, No mechanism, No directing, No following, No improvement, No evident.
1	System, Don't use system and mechanism to practice.
2	System, Let system and mechanism to practice, process evaluation, No improvement.
3	System, Let system and mechanism to practice, process evaluation, Improvement.
4	System, Let system and mechanism to practice, process evaluation, Improvement, Clearly improvement.
5	System, Let system and mechanism to practice, process evaluation, Improvement, Clearly improvement, Best practice.

Table 2 The evaluation criteria for indicator 3.3 and 4.3

score	result
0	No reporting.
1	Some result reporting.
2	Completely result reporting.
3	Completely result reporting, Good trend of some result.
4	Completely result reporting, Good trend of all result.
5	Completely result reporting, Good trend of all result, Outstanding result.

The experts have to assess an educational quality of a curriculum according to six components and fourteen indicators in self-assessment report (SAR) and they also have to give a score for each indicator. The experts will find it easy to give a score for the outcome indicators; however, they will find it hard to do the same for the process indicators. This is because the scores of the outcome indicators are calculated from quantitative data, for example, the number of the graduates employed, and the academic works published. On the contrary, the scores for the process indicators are based on the experts' discretion which is usually influenced or affected by a vagueness of qualitative data. Furthermore, if there is a difference in terms of the experts' discretion, there will be more difficulty for the experts to give a score. As a result, errors in giving score are more likely.

From the problem mentioned above, it always occurs in the other context in the real word. There are various situations that need making-decision by fuzzy linguistic term from imprecise knowledge of the expert such as "The admission is **slightly** clear", "The practice is **very high**". In 1975, Zadeh proposed fuzzy set to explain the linguistic variables to represent qualitative information of a person, to enhances the flexibility, feasibility and reliability of the making-decision process and obtain suitable output in various fields (Rodriguez and Martinez, 2013). The expert's opinions are used as the important information to evaluate any system. In general, the opinions are qualitative variable which replaced by linguistic variable. The value of such linguistic variable are established by a linguistic descriptors and its semantic, name is linguistic term such as *none*, *very low*, *low*, *medium*, *high* and *very high*. The virtual linguistic model is the important one that is used to represent and calculate the values of linguistic variable (Lio,Xu, Zeng and Merio, 2015). An important fundamental of the model is a subscript-symmetric additive linguistic term set (Xu, 2005) which is shown as:

$$S = \{s_t | t = -\tau, \ldots, -1, 0, 1, \ldots, \tau\}$$

Where s_t is linguistic term that represents the value of linguistic variable from experts' opinion to assess system, for example $s_{-2} = very\ low$, $s_{-1} = low$, $s_0 = medium$, $s_1 = high$ and $s_2 = very\ high$. s_0 represents outcome of assessment as indifferent. The element property of set S are as follow:

1) If $\alpha > \beta$ then $S_\alpha > S_\beta$

2) The negation operator is defined: $neg(s_\alpha) = s_\alpha$ and $neg(s_0) = s_0$

To support computation process, Xu (2004) extended the discrete linguistic term set S into continuous linguistic term set $\bar{S}$ that is defined as:

$$\bar{S} = \{s_\alpha | \alpha \in [-q, q]\}, \text{ where } q > \tau$$

Xu (2004) also introduced the operation law for any two linguistics term $s_\alpha, s_\beta \in \bar{S}$ and $\lambda, \lambda_1, \lambda_2 \in [0,1]$ as follow:

1) $s_\alpha \oplus s_\beta = s_{\alpha+\beta}$

2) $\lambda s_\alpha = s_{\lambda\alpha}$

3) $(\lambda_1 + \lambda_2)s_\alpha = \lambda_1 s_\alpha \oplus \lambda_2 s_\alpha$

4) $\lambda(s_\alpha \oplus s_\beta) = \lambda s_\alpha + \lambda s_\beta$

However, the approach that mentioned above is available for one linguistic term. Sometimes, imprecise knowledge of the experts requires more than one linguistic terms to describe because they might hesitate because of several linguistic terms. For example, "The admission is **at least slightly** clear", "The practice is **between normal and high**". Base on the such case lead Rodriguez, Martinez and Herrera (2012) to proposed the method to explain the linguistic terms by using hesitant fuzzy linguistic term set (HFLTS) and context-free grammars. The context-free grammars provide the rules for experts to establish the appropriate linguistic expression to making decision that can be switched into HFLTS. The HFLTS is a more powerful technique to represent the qualitative judgments form an experts' domain knowledge, when they assess any system. There are many scholars attracted to HFLTS. Rodriguez, Martinez and Herrera (2012) proposed the concept and properties of HELTS including its basic operations. They also proposed a multi-criteria linguistic decision making model with linguistic expression based on comparative terms. Lio, Xu and Zeng (2014) introduced the method for the multi-criteria decision making (MCDM) under hesitant fuzzy linguistic with a sort of distance and similarity measure for HFLTSs. Wei, Zhao and Tang (2014) studied about operators and comparisons of HELTS, lead to the development of some comparison methods and studied aggregation theory for HELTS. Chen and Hong (2014) presented the method by using the pessimistic and the optimistic attitude of the experts for multi-criteria linguistic decision based on HELTSs. Liu and Rodriguez (2014) proposed a new representation of the HELTS, which can be used to carry out the computing with word process. Zhu and Xu (2014) proposed the method to measure the hesitant fuzzy linguistic preference relations and proved its consistency. Liu, Cai and Jiang (2014) improved the additive consistency of the fuzzy preference relations based on comparative linguistic expression. Rodriguez, Martinez and Herrera (2013) proposed a group decision-making model dealing with comparative linguistic expressions based on HELTS.

To use the linguistic term to represent experts' opinion with the most efficiency, Lio, Xu and Zeng (2014) gave definition of the hesitant fuzzy linguistic term set (HFLTS) as follows:

Definition 1. Let $x_i \in X$, $i = 1, 2, \ldots, N.$ be fixed and $S = \{s_t | t = -\tau, \ldots, -1, 0, 1, \ldots, \tau\}$ be a linguistic term set a hesitant fuzzy linguistic term set on X in mathematical term is

$$H_s = \{\langle x_i, h_s(x_i)\rangle | x_i \in X\}, \text{ where}$$

$$h_s(x_i) = \{s_{\phi_l}(x_i) | s_{\phi_l}(x_i) \in S, l = 1,2,\ldots,L\}$$

with L being the number of linguistic term in $h_s(x_i)$, $h_s(x_i)$ is called the hesitant fuzzy linguistic element (HFLE).

Lio, Xu, Zeng and Merio (2015) gave a simple example to understand concept about HFLTS, in circumstance an expert evaluates the operational complexity of three automatic systems. The three systems can be represented as x_1, x_2 and x_3 respectively. The linguistic term set for the operational complexity can be set up as:

$S = \{s_{-3}, s_{-2}, s_{-1}, s_0, s_1, s_2, s_3\}$, where

s_{-3} = *very complex*, s_{-2} = *complex*,

s_{-1} = *little complex*, s_0 = *medium*,

s_1 = *a little easy*, s_2 = *easy* and s_2 = *very easy*

In case, the expert determines his/her judgments over these three automatic systems with linguistic expression, which are the first is *at least a little easy* ,the second is *between complex and medium* and the third is *great than easy*. A HFLTS can be represented the expert's judgments over these three automatic systems as follow:

$$H_s = \{\langle x_1, h_s(x_1)\rangle, \langle x_2, h_s(x_2)\rangle, \langle x_3, h_s(x_3)\rangle\}$$

Where, $h_s(x_1) = \{s_1, s_2, s_3\}$,

$h_s(x_2) = \{s_{-2}, s_{-1}, s_0\}$ and $h_s(x_3) = \{s_3\}$

There are many scholars have been studied about correlation coefficients between HELTS. Lio, Xu, Zeng and Merio (2015) proposed several important correlation measures and correlation coefficients for HELTS, which enabled us to assess or diagnosis interesting situation under hesitant fuzzy linguistic circumstance. Murithy, Pal and Dutra-Majumder (1985) proposed the correlation between fuzzy membership function. They gave a formula to calculate the correlation measure between two fuzzy membership function. Chaudhuri and Bhattacharya (2001) adopted the concepts from conventional statistics to extend Murthy et al.'s correlation formula for the rank correlation measure. Chiang and Lin (1999) proposed another formula correlation coefficients to measure correlation on the domain of fuzzy set. Yu (1993) introduced quite difference concept to calculate the correlation and correlation coefficients to measure the interrelation of fuzzy number and the value of the correlation coefficients lie in the interval [0, 1]. Hung (2001) developed correlation measurement of intuitionistic fuzzy set by using statistical viewpoint, correlation between two separate fuzzy set was calculated from the membership degree and non-membership degree. Mitchell (2004) proposed a correlation coefficients for intuitionistic fuzzy set by taking the hesitant degree of the set into Hung's formula. Szmidt and Kacprzyk (2010) improved version of correlation measures for intuitionistic fuzzy set, they defined the set as the ensemble of ordinary membership function. These correlation measures are based on traditional statistics. There are also scholars who investigated and improved the correlation measures, in which their study lead to many different from of correlation measures for intuitionistic fuzzy set. The scholars in question included Gerstenkorn and Manko (1991), Hong and Hwang (1995), Huang and Wu (2002) and Xu (2006). The correlation coefficients was derived by these information-energy-based and its value lie in unit interval [0, 1]. Recently, Chen, Xu and Xia (2013) proposed the correlation coefficients of hesitant fuzzy set (HFSs) and their application to clustering analysis. In which, Chen et al.'s study gave a formula to calculate the correlation between HFSs that was the fundamental formula for Lio, Xu, Zeng and Merio (2015) to conduct a later study about qualitative decision- making with correlation coefficientss of HFLTS.

Furthermore, Lio, Xu, Zeng and Merio (2015) also gave useful definitions about the correlation coefficients between two HFLTSs as follow:

Definition 2. Let $x_i \in X$, $i = 1,2,\ldots,N$. be fixed and $S = \{s_t | t = -\tau,\ldots,-1,0,1,\ldots,\tau\}$ be a linguistic term set. For two HFLTSs

$H_s^1 = \{\langle x_i, h_s^1(x_i)\rangle | x_i \in X\}$ and
$H_s^2 = \{\langle x_i, h_s^2(x_i)\rangle | x_i \in X\}$ with
$h_s^k(x_i) = \{s_{\delta_l^k} | s_{\delta_l^k} \in S, l = 1,2,\ldots,L_i\}, k = 1,2$,
the correlation between H_s^1 and H_s^2 is defined as:

$$C(H_s^1, H_s^2) = \sum_{i=1}^{N}\left[\frac{1}{L_i}\sum_{i=1}^{L_i}\left(\frac{|\delta_l^1(x_i)|}{2\tau+1}\cdot\frac{|\delta_l^2(x_i)|}{2\tau+1}\right)\right] \quad (1)$$

Where L_i is the maximum number of linguistic term in $h_s^1(x_i)$ and $h_s^2(x_i)$

Definition 3. Let $x_i \in X$, $i = 1,2,\ldots,N$. be fixed and $S = \{s_t | t = -\tau,\ldots,-1,0,1,\ldots,\tau\}$ be a linguistic term set. For two HFLTSs
$H_s^1 = \{\langle x_i, h_s^1(x_i)\rangle | x_i \in X\}$ and
$H_s^2 = \{\langle x_i, h_s^2(x_i)\rangle | x_i \in X\}$ with
$h_s^k(x_i) = \{s_{\delta_l^k} | s_{\delta_l^k} \in S, l = 1,2,\ldots,L_i\}, k = 1,2$,
the correlation coefficients between H_s^1 and H_s^2 is defined as:

$$\rho(H_s^1, H_s^2) = \frac{\sum_{i=1}^{N}\left[\frac{1}{L_i}\sum_{i=1}^{L_i}\left(|\delta_l^1(x_i)|\cdot|\delta_l^2(x_i)|\right)\right]}{\sqrt{\sum_{i=1}^{N}\left(\frac{1}{L_i}\sum_{i=1}^{L_i}(\delta_l^1(x_i))^2\right)\cdot\sum_{i=1}^{N}\left(\frac{1}{L_i}\sum_{i=1}^{L_i}(\delta_l^2(x_i))^2\right)}} \quad (2)$$

Where L_i is the maximum number of linguistic term in $h_s^1(x_i)$ and $h_s^2(x_i)$

Property For HFLTSs H_s^1 and H_s^2, the property of correlation coefficients between H_s^1 and H_s^2 are as follow:

1) $\rho(H_s^1, H_s^2) = 1$
2) if $H_s^1 = H_s^2$ then $\rho(H_s^1, H_s^2) = 1$
3) $\rho(H_s^1, H_s^2) = \rho(H_s^2, H_s^1)$

Theorem For HFLTSs H_s^1 and H_s^2, $0 \le \rho(H_s^1, H_s^2) \le 1$

To applied the formula of correlation coefficients, we assume that the linguistic terms in each HFLE are arranged in ascending order and the short HFLEs are extended by adding some linguistic terms till they have same length. The linguistic terms that we added are $\bar{s} = \frac{1}{2}(s^+ \oplus s^-)$ where s^+ and s^- are the maximal and minimal term in HFLE. The translation of the value of the correlation coefficients is same as in classical statistic. They also applied the correlation coefficients of HFLTS to a traditional Chinese medical diagnosis. The application shown that correlation coefficients of HFLTS were applicability and validation.

From the above problem, this research object to study the appropriate method to give the score for the process indicators by using correlation coefficients of hesitant fuzzy linguistic term sets (HFLTS).

Research Objective

The purposes of this research were:

1. To study the new method in scoring for the process indicators of the internal educational quality assurance in high education, by using correlation coefficients of hesitant fuzzy linguistic term sets.

2. To compare the assessment score on educational quality of curriculums in the Faculty of Science Ubon Ratchathani Rajabhat University according to the process

indicators of the internal education quality assurance in higher education, between correlation coefficients of hesitant fuzzy linguistic term sets application and traditional method in scoring.

Methodology

Participants

Target population included 24 experts that were appointed by the Higher Education Office to evaluate an education quality. They were selected by purposive sampling. Eight departments (curriculum) in faculty of science Ubon Rachthani Rajabhat university included mathematics, applied statistics, environment technology, environmental science, micro biology, biology, chemistry and physics.

Data collection

Research instrument included self-assessment reports of all eight departments in the study and the education quality evaluation forms:

1. The self-assessment reports consist of 9 indicators: 3.1: admission, 3.2: promotion and development of students, 3.3: effect on students, 4.1: management and development of teachers, 4.3: effect on teachers, 5.1: substance of subject, 5.2: teacher system and teaching process, 5.3: student evaluation and 6.1: learning support.

2. The education quality evaluation forms consist of 59 questions, For indicator 3.1: admission, 3.2: promotion and development of students, 4.1 management and development of teachers, 5.1 substance of subject, 5.2: teacher system and teaching process, 5.3: student evaluation and 6.1: learning support, questions no. one to no. six of each indicator were used to motivate the expert to show their opinion to adjudge the indicators according to six components: system, practice, evaluation, improvement, result and best practice. The answers were linguistic term such as *none*, *no clear*, *rather clear*, *clear*, *more clear*, *very clear* and *most clear*. The seventh question of each indicator was used to motivate the expert to give the overview score for each indicator such as 0, 1, 2, 3, 4, 5. For indicator 3.3: effect on students and 4.3, questions (one to four) of each indicator were used to motivate the expert to show their opinion to adjudge the indicators according to four components: result report, completion of implementation, trend of results and outstanding results. The answer were linguistic term such as *none*, *no clear*, *rather clear*, *clear*, *more clear*, *very clear* and *most clear*. The number five question of each indicator was used to motivate the expert to give the overview score for each indicator such as 0, 1, 2, 3, 4, 5.

Data collection: A curriculum was evaluated by three experts. Each expert received self-assessment reports and evaluation form they then consider and examine the self-assessment reports to adjudge the curriculum. They could ask for more information from the committee in charge in case they had some questions the would answer the questions as stated in the evaluation form.

Data analysis

After data were collected, they were analyzed in the following steps.

1. For indicator 3.1: admission, 3.2: promotion and development of students, 4.1 management and development of teachers, 5.1 substance of subject, 5.2: teacher system and teaching process, 5.3: student evaluation and 6.1: learning support, let each component of indicator as: x_1 is system, x_2 is practice, x_3 is evaluation, x_4 is improvement, x_5 is result and x_6 is best practice. For indicator 3.3 and 4.3 effect on teachers, let each component of indicator as: x_1 is result report, x_2 is completion of implementation, x_3 is trend of result and x_4 is outstanding result. Furthermore, let linguistic term to adjudge the component as s_{-3} is *none*, s_{-2} is *no clear*, s_{-1} is *rather clear*, s_0 is *clear*, s_1 is *more clear*, s_2 is *very clear* and s_3 is *most clear*. Then HFLTS were established to explain each score for each indicator as follow:

1.1 For indicators 3.1: admission, 3.2: promotion and development of students, 4.1 management and development of teachers, 5.1 substance of subject, 5.2: teacher system and teaching process, 5.3: student evaluation and 6.1: learning support, the HFLTS were used to explain each score as follow:

$$\text{Score 0: } H_S = \{\langle x_1,\{s_{-3}\}\rangle,\langle x_2,\{s_{-3}\}\rangle,\langle x_3,\{s_{-3}\}\rangle,\langle x_4,\{s_{-3}\}\rangle,\langle x_5,\{s_{-3}\}\rangle,\langle x_6,\{s_{-3}\}\rangle\}$$
$$\text{Score 1: } H_S = \{\langle x_1,\{s_0,s_1,s_2,s_3\}\rangle,\langle x_2,\{s_{-3}\}\rangle,\langle x_3,\{s_{-3}\}\rangle,\langle x_4,\{s_{-3}\}\rangle,\langle x_5,\{s_{-3}\}\rangle,\langle x_6,\{s_{-3}\}\rangle\}$$
$$\text{Score 2: } H_S = \left\{\begin{matrix}\langle x_1,\{s_0,s_1,s_2,s_3\}\rangle,\langle x_2,\{s_0,s_1,s_2,s_3\}\rangle,\langle x_3,\{s_0,s_1,s_2,s_3\}\rangle,\\ \langle x_4,\{s_{-3}\}\rangle,\langle x_5,\{s_{-3}\}\rangle,\langle x_6,\{s_{-3}\}\rangle\end{matrix}\right\}$$
$$\text{Score 3: } H_S = \left\{\begin{matrix}\langle x_1,\{s_0,s_1,s_3\}\rangle,\langle x_2,\{s_0,s_1,s_2,s_3\}\rangle,\langle x_3,\{s_0,s_1,s_2,s_3\}\rangle,\\ \langle x_4,\{s_0,s_1,s_2,s_3\}\rangle,\langle x_5,\{s_{-3}\}\rangle,\langle x_6,\{s_{-3}\}\rangle\end{matrix}\right\}$$
$$\text{Score 4: } H_S = \left\{\begin{matrix}\langle x_1,\{s_0,s_1,s_3\}\rangle,\langle x_2,\{s_0,s_1,s_2,s_3\}\rangle,\langle x_3,\{s_0,s_1,s_2,s_3\}\rangle,\\ \langle x_4,\{s_0,s_1,s_2,s_3\}\rangle,\langle x_5,\{s_0,s_1,s_2,s_3\}\rangle,\langle x_6,\{s_{-3}\}\rangle\end{matrix}\right\}$$
$$\text{Score 5: } H_S = \left\{\begin{matrix}\langle x_1,\{s_0,s_1,s_3\}\rangle,\langle x_2,\{s_0,s_1,s_2,s_3\}\rangle,\langle x_3,\{s_0,s_1,s_2,s_3\}\rangle,\\ \langle x_4,\{s_0,s_1,s_2,s_3\}\rangle,\langle x_5,\{s_0,s_1,s_2,s_3\}\rangle,\langle x_6,\{s_0,s_1,s_2,s_3\}\rangle\end{matrix}\right\}$$

1.2 For indicators 3.3: effect on students and 4.3 effect on teachers, the HFLTS were used to explain each score are as follow:

$$\text{Score 0: } H_S = \{\langle x_1,\{s_{-3}\}\rangle,\langle x_2,\{s_{-3}\}\rangle,\langle x_3,\{s_{-3}\}\rangle,\langle x_4,\{s_{-3}\}\rangle\}$$
$$\text{Score 1: } H_S = \{\langle x_1,\{s_0,s_1,s_2,s_3\}\rangle,\langle x_2,\{s_{-2},s_{-1}\}\rangle,\langle x_3,\{s_{-3}\}\rangle,\langle x_4,\{s_{-3}\}\rangle\}$$
$$\text{Score 2: } H_S = \{\langle x_1,\{s_0,s_1,s_2,s_3\}\rangle,\langle x_2,\{s_0,s_1,s_2,s_3\}\rangle,\langle x_3,\{s_{-3}\}\rangle,\langle x_4,\{s_{-3}\}\rangle\}$$
$$\text{Score 3: } H_S = \{\langle x_1,\{s_0,s_1,s_2,s_3\}\rangle,\langle x_2,\{s_0,s_1,s_2,s_3\}\rangle,\langle x_3,\{s_{-2},s_{-1}\}\rangle,\langle x_4,\{s_{-3}\}\rangle\}$$
$$\text{Score 4: } H_S = \{\langle x_1,\{s_0,s_1,s_2,s_3\}\rangle,\langle x_2,\{s_0,s_1,s_2,s_3\}\rangle,\langle x_3,\{s_0,s_1,s_2,s_3\}\rangle,\langle x_4,\{s_{-3}\}\rangle\}$$
$$\text{Score 5: } H_S = \{\langle x_1,\{s_0,s_1,s_2,s_3\}\rangle,\langle x_2,\{s_0,s_1,s_2,s_3\}\rangle,\langle x_3,\{s_0,s_1,s_2,s_3\}\rangle,\langle x_4,\{s_0,s_1,s_2,s_3\}\rangle\}$$

2. HFLTS were established to explain the opinion of the experts to assess each indicator of each curriculum.

3. The correlation coefficients between HFLTS in 1 and 2 was calculated by formula (2).

Example Let H_S^1 is the HFLTS that used to explain the score 3 for indicator 4.3 and H_S^2 is the HFLTS that used to explain the opinion of the expert to assess indicator 4.3 of a curriculum.

$$H_S^1 = \{\langle x_1,\{s_0,s_1,s_2,s_3\}\rangle,\langle x_2,\{s_0,s_1,s_2,s_3\}\rangle,\langle x_3,\{s_{-2},s_{-1}\}\rangle,\langle x_4,\{s_{-3}\}\rangle\}$$
$$H_S^2 = \{\langle x_1,\{s_{-1},s_0\}\rangle,\langle x_2,\{s_{-2},s_{-1},s_0\}\rangle,\langle x_3,\{s_{-3},s_{-1}\}\rangle,\langle x_4,\{s_{-3},s_{-2},s_{-1}\}\rangle\}$$

The solution of correlation coefficients between H_S^1 and H_S^2 as follow:

Firstly, extending the elements of both H_S^1 and H_S^2 to the equal length by adding the corresponding averaging linguistic terms, they follow that

$$H_S^1 = \{\langle x_1, \{s_0, s_1, s_2, s_3\}\rangle, \langle x_2, \{s_0, s_1, s_2, s_3\}\rangle, \langle x_3, \{s_{-2}, s_{-1}\}\rangle, \langle x_4, \{s_{-3}, s_{-3}, s_{-3}\}\rangle\}$$
$$H_S^1 = \{\langle x_1, \{s_{-1}, s_{-.5}, s_{-.5}, s_0\}\rangle, \langle x_2, \{s_{-2}, s_{-1}, s_{-1}, s_0\}\rangle, \langle x_3, \{s_{-3}, s_{-1}\}\rangle, \langle x_4, \{s_{-3}, s_{-2}, s_{-1}\}\rangle\}$$

$$\rho(H_s^1, H_s^2) = \frac{\sum_{i=1}^{N}\left[\frac{1}{L_i}\sum_{i=1}^{L_i}\left(\left|\delta_l^1(x_i)\right| \cdot \left|\delta_l^2(x_i)\right|\right)\right]}{\sqrt{\sum_{i=1}^{N}\left(\frac{1}{L_i}\sum_{i=1}^{L_i}\left(\delta_l^1(x_i)\right)^2\right) \cdot \sum_{i=1}^{N}\left(\frac{1}{L_i}\sum_{i=1}^{L_i}\left(\delta_l^2(x_i)\right)^2\right)}}$$

$$\begin{aligned}\sum_{i=1}^{N}\left[\frac{1}{L_i}\sum_{i=1}^{L_i}\left(\left|\delta_l^1(x_i)\right| \cdot \left|\delta_l^2(x_i)\right|\right)\right] &= \frac{1}{4}\left(|0|\cdot|-1| + |1|\cdot|-0.5| + |2|\cdot|-0.5| + |3|\cdot|0|\right) + \frac{1}{4}\left(|0|\cdot|-2| + |1|\cdot|-1| + |2|\cdot|-1| + |3|\cdot|0|\right) \\ &+ \frac{1}{2}\left(|-2|\cdot|-3| + |-1|\cdot|-1|\right) + \frac{1}{3}\left(|-3|\cdot|-3| + |-3|\cdot|-2| + |-3|\cdot|-1|\right) \\ &= 11.375\end{aligned}$$

$$\begin{aligned}\sum_{i=1}^{N}\left(\frac{1}{L_i}\sum_{i=1}^{L_i}\left(\delta_l^1(x_i)\right)^2\right) &= \frac{1}{4}\left(0^2 + 1^2 + 2^2 + 3^2\right) + \frac{1}{4}\left(0^2 + 1^2 + 2^2 + 3^2\right) \\ &+ \frac{1}{2}\left((-2)^2 + (-1)^2\right) + \frac{1}{3}\left((-3)^2 + (-3)^2 + (-3)^2\right) \\ &= 15\end{aligned}$$

$$\begin{aligned}\sum_{i=1}^{N}\left(\frac{1}{L_i}\sum_{i=1}^{L_i}\left(\delta_l^1(x_i)\right)^2\right) &= \frac{1}{4}\left(0^2 + (-0.5)^2 + (-0.5)^2 + 0^2\right) + \frac{1}{4}\left((-2)^2 + (-1)^2 + (-1)^2 + (0)^2\right) \\ &+ \frac{1}{2}\left((-3)^2 + (-1)^2\right) + \frac{1}{3}\left((-3)^2 + (-2)^2 + (-1)^2\right) \\ &= 11.292\end{aligned}$$

Thus, the correlation coefficients is derived by (2): $\rho(H_s^1, H_s^2) = \frac{11.375}{\sqrt{(15)\cdot(11.292)}} = 0.874$

That is to say, the educational quality of the curriculum in indicator 4.3 effect on teachers and the score 3 for indicator 4.3 have a high correlation coefficients.

4. The value of correlation coefficients was interpreted. A coefficients with maximum value would be a determinant of the scores for each indicator of each curriculum in the study.

5. The mode of the educational quality scores of each indicator as judged by the experts was to be found based on the seventh question of the education quality forms. The traditional method to give the score for each indicator is bases on the mode.

6. The scores from step 4 and step 5 are compared.

Result

The new method to give the score for the process indicators of an internal education quality assurance in the high education by using correlation coefficients of hesitant fuzzy linguistic term sets are composed of 4 steps are as follows:

1) Creating the HFLTS to explain each score for each indicator according to evaluation criteria.

2) Creating the HFLTS to explain the experts' opinion which used to assess each indicator of each curriculum.

3) Finding the correlation coefficients between the HFLTS in 1) and 2).

4) Interpreting the correlation coefficients, a maximal value of the correlation coefficients would be a determinant of the score for each indicator of each curriculum.

Under the ethics of research, this paper cannot reveal the name of the curriculum. By using the correlation coefficients of HFLTS to evaluate educational quality, it means that the points of most indicators of each curriculum are 0 and 1, which is less than mode. Importantly, some indicators have no mode of the quality score. By using the value of HFLTS correlation coefficients, it is possible to determine the score of the indicators. The curriculum with a maximum educational quality was C opposite to curriculum D which had a minimum educational quality. The value of correlation coefficients of HFLTS between each indicator and scores of each curriculum can be illustrated in tables 1-8 as below.

Table 3 The correlation coefficients between each education quality indicator and each score of curriculum A

Score	Indicator								
	3.1	3.2	3.3	4.1	4.3	5.1	5.2	5.3	6.1
0	0.8333	0.9449	**0.8922**	**0.9532**	**0.8607**	**0.9532**	0.9258	**0.9475**	**0.9532**
1	**0.8441**	0.9273	0.8858	0.9381	0.7906	0.9381	**0.9362**	0.8702	0.9381
2	0.7800	0.8618	0.8273	0.5389	0.6790	0.5389	0.8911	0.8212	0.5432
3	0.6712	0.7979	0.8108	0.8096	0.7449	0.8096	0.8268	0.8548	0.8096
4	0.6662	0.7284	0.7439	0.7719	0.6985	0.7719	0.7572	0.6429	0.7719
5	0.6032	0.6536	0.6178	0.5996	0.6134	0.5996	0.5946	0.6351	0.5996
score	1	0	0	0	0	0	1	0	0
Mode	2	-	3	2	2	2	2	2	2

Table 4 The correlation coefficients between each education quality indicator and each score of curriculum B

Score	Indicator								
	3.1	3.2	3.3	4.1	4.3	5.1	5.2	5.3	6.1
0	0.8398	**0.8379**	**0.8839**	**0.7404**	**0.9201**	**0.7121**	0.5442	0.6239	**0.7127**
1	**0.8437**	0.7871	0.8690	0.7049	0.9041	0.7048	**0.6023**	**0.6584**	0.6991
2	0.7505	0.6867	0.7955	0.6139	0.8859	0.6429	0.5698	0.6390	0.6147
3	0.6906	0.6305	0.7740	0.5395	0.8159	0.5364	0.4920	0.5729	0.5352
4	0.5675	0.4887	0.6405	0.4124	0.7632	0.4142	0.4036	0.4454	0.4451
5	0.4599	0.3452	0.5079	0.2518	0.6434	0.2693	0.2489	0.2682	0.2777
score	1	0	0	0	0	0	1	1	0
Mode	3	-	3	3	2	3	3	4	4

Table 5 The correlation coefficients between each education quality indicator and each score of curriculum C

Score	Indicator								
	3.1	3.2	3.3	4.1	4.3	5.1	5.2	5.3	6.1
0	**0.9095**	**0.7804**	**0.8199**	**0.7995**	0.7001	0.8219	**0.8041**	0.7737	0.8508
1	0.9170	0.7763	0.8049	0.7642	**0.7039**	0.8296	0.8013	0.7735	0.8616
2	0.8913	0.7901	0.7965	0.7111	0.5986	0.8362	0.7505	**0.7819**	0.9057
3	0.8270	0.7994	0.7897	0.6415	0.5657	0.8588	0.7659	0.7339	0.9448
4	0.7574	0.8172	0.7780	0.5840	0.4757	**0.8928**	0.7907	0.6758	0.9403

Table 5 (Cont.)

Score	Indicator								
	3.1	3.2	3.3	4.1	4.3	5.1	5.2	5.3	6.1
5	0.7071	0.85172	0.7722	0.5901	0.4491	0.8192	0.7617	0.5650	**0.9493**
score	**1**	**0**	**0**	**0**	**1**	**4**	**0**	**2**	**5**
Mode	**4**	**-**	**-**	**4**	**-**	**3**	**3**	**4**	**-**

Table 6 The correlation coefficients between each education quality indicator and each score of curriculum D

Score	Indicator								
	3.1	3.2	3.3	4.1	4.3	5.1	5.2	5.3	6.1
0	**0.9178**	**0.9532**	**0.9139**	**0.9396**	**0.7845**	**0.8333**	**0.9532**	**0.9258**	**0.9532**
1	0.8948	0.9381	0.8395	0.9220	0.7806	0.8266	0.9381	0.9057	0.9381
2	0.8340	0.8689	0.8225	0.8569	0.7649	0.7600	0.8689	0.8332	0.8689
3	0.7732	0.80963	0.8347	0.7933	0.7295	0.7036	0.8096	0.7767	0.8096
4	0.7073	0.74576	0.7761	0.6483	0.6828	0.6424	0.7458	0.7021	0.7458
5	0.5296	0.67822	0.6281	0.4786	0.5897	0.5764	0.6782	0.6205	0.6782
score	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Mode	**2**	**1**	**2**	**1**	**2**	**2**	**2**	**-**	**2**

Table 7 The correlation coefficients between each education quality indicator and each score of curriculum E

Score	Indicator								
	3.1	3.2	3.3	4.1	4.3	5.1	5.2	5.3	6.1
0	0.9120	0.7124	0.5875	0.8688	0.7994	0.79783	0.8438	0.8468	0.7414
1	0.9309	0.7105	0.6329	0.8342	0.8431	0.76900	0.8508	0.8525	0.7279
2	0.8327	0.6203	0.5875	0.7767	0.7630	0.67662	0.7651	0.7673	0.6672
3	0.7726	0.5135	0.5616	0.7223	0.7181	0.60789	0.7673	0.7256	0.6019
4	0.6934	0.4155	0.5100	0.6077	0.5349	0.68990	0.6625	0.5983	0.4777
5	0.6219	0.2725	0.3402	0.5101	0.3399	0.38256	0.5354	0.4657	0.3313
score	**1**	**0**	**1**	**0**	**1**	**0**	**1**	**1**	**0**
Mode	**3**	**2**	**3**	**3**	**3**	**3**	**-**	**-**	**-**

Table 8 The correlation coefficients between each education quality indicator and each score of curriculum F

Score	Indicator								
	3.1	3.2	3.3	4.1	4.3	5.1	5.2	5.3	6.1
0	**0.9533**	**0.9533**	0.7359	**0.9532**	**0.9624**	0.8172	0.8752	**0.9847**	0.9197
1	0.9382	0.9382	**0.7569**	0.9381	0.9187	**0.8392**	**0.8876**	0.9417	**0.9273**
2	0.8689	0.8689	0.7133	0.8689	0.9002	0.7845	0.8465	0.8586	0.8618
3	0.8097	0.8097	0.6713	0.8096	0.8621	0.7041	0.7351	0.8195	0.7979
4	0.7458	0.7458	0.6538	0.7458	0.8077	0.5988	0.6300	0.7797	0.7284
5	0.5947	0.5947	0.5220	0.5947	0.7036	0.4404	0.5097	0.7425	0.6536
score	**0**	**0**	**1**	**0**	**0**	**1**	**1**	**0**	**1**
Mode	**1**	**2**	**2**	**1**	**2**	**2**	**-**	**2**	**2**

Table 9 The correlation coefficients between each education quality indicator and each score of curriculum G

Score	Indicator								
	3.1	3.2	3.3	4.1	4.3	5.1	5.2	5.3	6.1
0	0.8874	0.9913	0.6804	0.8573	0.8660	0.8172	0.7999	0.6239	0.7217
1	0.8583	0.9728	0.6979	0.8400	0.8271	0.8234	0.7913	0.6065	0.7465
2	0.7987	0.8803	0.6328	0.7593	0.7794	0.7452	0.8099	0.5745	0.7009
3	0.7265	0.8242	0.6249	0.6762	0.7527	0.6475	0.7145	0.5590	0.5983
4	0.6485	0.7642	0.5085	0.6410	0.6724	0.5367	0.6067	0.4223	0.4880
5	0.5608	0.6379	0.2591	0.6075	0.5456	0.4404	0.4826	0.2336	0.3590
score	**0**	**0**	**1**	**1**	**0**	**1**	**0**	**0**	**1**
Mode	**3**	-	-	-	**3**	-	-	-	-

Table 10 The correlation coefficients between each education quality indicator and each score of curriculum H

Score	Indicator								
	3.1	3.2	3.3	4.1	4.3	5.1	5.2	5.3	6.1
0	0.8846	**0.9532**	**0.7217**	0.8642	**0.9354**	0.9245	**0.9797**	**0.9449**	**0.9449**
1	**0.9029**	0.9381	0.6997	**0.8808**	0.9001	**0.9517**	0.8808	0.9273	0.9273
2	0.8308	0.8689	0.6495	0.8367	0.8819	0.8794	0.8367	0.8618	0.8618
3	0.7619	0.8096	0.6208	0.7655	0.9009	0.8177	0.7655	0.7979	0.7979
4	0.6863	0.7458	0.5638	0.6869	0.8398	0.7511	0.68695	0.7284	0.7284
5	0.6032	0.6782	0.5786	0.5990	0.6964	0.5984	0.60034	0.6536	0.6536
score	**1**	**0**	**1**	**1**	**0**	**1**	**0**	**0**	**0**
Mode	**2**	**2**	**2**	**2**	**3**	**2**	**2**	**1**	**2**

Discussion

This paper aims to propose the alternative method to evaluate education quality of curriculum by using the correlation coefficients of HFLTS. The method is according to an application of the correlation coefficients of HFLTS to a traditional Chinese medical diagnosis as proposed by Lio, Xu, Zeng and Merio (2015). In addition, the method resembles an application of correlation coefficients of dual hesitant fuzzy sets proposed by Tyagi (2015) to evaluate the relationship between three different parameters of water in four lake. The result founded that the score of mostly quality education indicators of each curriculum is 0 and 1, which is lower than the mode. This is each indicator is difficult to put into practice. This is the first time of educational quality assurance at curriculum or curriculum level. In the present research, experts were free to judge the questions in the evaluation form. The results did not affect the educational quality in the real circumstance. They use only in the research. Therefore, experts made their own judgment similar own views, which was negative to the educational quality of each curriculum. However, as regards an overall education quality the experts gave scores higher than 0 and 1 as they did not want to judge the curriculum at the 'fail' level. Thank to previously mention, scoring by using the correlation of HFLTS is more realistic than the traditional method. It was shown that the curriculum with a maximum quality was C while the curriculum with a minimum quality was D. The results found had confirmed congruence between the scores gained from the correlation coefficients and mode.

Conclusion and Suggestion

An educational quality assurance at the curriculum level depends on peer review. The week points of the method are often found. Different views of the experts lead to difficulty in giving point of the educational quality.

The present research aimed to find a new method of an evaluation by using the correlation coefficients of HFLTS. Scores of each indicator are changed in to HFLTS and the linguistic term representing the experts' opinion are changed into HFLTS. The correlation coefficients between the two is calculated. The maximum value of the correlation coefficients is a determinant of score for each indicator. Beside that, scores of each indicator can be determined by the mode of an educational quality. To acquire an appropriate score of each indicator, the expert have to consider the score of both the correlation coefficients and the mode. Calculation by manual is very difficult so we should establish software to calculate the correlation coefficients between HFLTS.

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