



Inquiring the Most Critical Teacher's Technology Education Competences in the Highest Efficient Technology Education Learning Organization

Chan Yung-Kuan

National Chung Hsing University, TAIWAN

Ming-Yuan Hsieh

National Taichung University of Education, TAIWAN

Chin-Feng Lee

Chaoyang University of Technology, TAIWAN

Chih-Cheng Huang

National Formosa University, TAIWAN

Li-Chih Ho

National Chung-Hsing University, TAIWAN

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ABSTRACT

Under the hyper-dynamic education situation, this research, in order to comprehensively explore the interplays between Teacher Competence Demands (TCD) and Learning Organization Requests (LOR), cross-employs the data refined method of Descriptive Statistics (DS) method and Analysis of Variance (ANOVA) and Principal Components Analysis (PCA) approaches to cross-analyze the empirical questionnaires of senior high schools in Changhua and Taichung regions in Taiwan from four brief analytical perspectives, including Individual Demand Competency (IDC), Professional Knowledge Competency (PKC), Resource Satisfaction Competency (RSC) and Cooperative Relationship Competency (CRC). Based on the results of evaluated measurements, the four most decisive TCDs for constructing the potential LOR are "reading competency for IDC", "cross-subjects and empirical teaching competencies for PKC", "convincing competency for RSC" and "cooperative competency" which is the most ponderable contribution of this research. Furthermore, in order to survive in the lowest birth-rate and highest democratic-rights education era, Taiwanese senior high schools must concretely put more school's administrative resource and aggressively collect more sponsoring from non-for-profit education organizations and governmental education departments to provide a series of empirical and digital on-job certificate programs and training license courses to assist teachers to nurture these most critical TCDs including reading, cross-subjects and empirical teaching, convincing and cooperative.

Keywords: teacher competency demand (TCD), learning organization request (LOR), descriptive statistics (DS), analysis of variance (ANOVA), principal components analysis (PCA)

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Correspondence: Ming-Yuan Hsieh, *Department of International Business, National Taichung University of Education, Taichung City 40306, Taiwan.*

✉ cpawisely@mail.ntcu.edu.tw

State of the literature

- The most critical teacher's technology education competences in the highest efficient technology education learning organization are completely identified, evaluated and refined through a series of empirical questionnaires surveyed in order to resupply academic gap in relative online learning literatures.
- The data refined method of descriptive statistics (DS) method and analysis of variance (ANOVA) and principal components analysis (PCA) approaches of Factor Analysis (FA) approaches for increment of research reliability and validity are cross-employed this research.

Contribution of this paper to the literature

- The most valuable induction is to directly conclude the four most decisive TCDs for constructing the potential LOR that are "reading competency for IDC", "cross-subjects and empirical teaching competencies for PKC", "convincing competency for RSC" and "cooperative competency".
- Taiwanese senior high schools have to completely put further school's administrative resource and aggressively collect more sponsoring from non-for-profit education organizations and governmental education departments to provide a series of empirical and digital on-job certificate programs and training license courses to cultivate teachers' core competences.

INTRODUCTION

According to 2016 annual official statistic report of the Taiwanese Ministry of Education, the total number of recruited students in senior high schools is going to decrease over 20,000 in 2016 which compared with the total number of registered students in 2014 and specially, taking the various aspirations of each student into consideration, the 12-year Compulsory Education Law has been implemented in 2014 which legally expands the original 9-year compulsory education. Particularly, in order to follow this crucial development of 12-compulsory education system, Taiwanese senior high schools have to not only accentuate the traditional academic subjects for colleges and universities entrance examinations but also more focus on the vocational empirical disciplines for each student's individual will (Becker, McElvany, & Kortenbruck, 2010). As for adopting this current educational tendency, the Taiwanese Ministry of Education also has introduced and implemented 『Twelve Education Revolution Actions Items』 to not only encourage Taiwanese teachers to take a series of on-job programs and training courses, including technological education, distance education teaching and internet digital education (Hsieh, 2016) but also stimulate senior high schools to concretely form Learning Organization ("LO") (Arnold, 1982; Ainsworth, Prain, & Tytler, 2011). Furthermore, the fundamental SWOT (strength, weakness, opportunity and threat) analysis of on-job training courses for current senior high school teachers are illustrated in [Table 1](#).

Table 1. SWOT analysis of on-job training courses for current senior high school teachers

	Strength (S)	Weakness (W)
Opportunity (O)	<ol style="list-style-type: none"> 1. Teachers hardly have the strong learning motivation. 2. Teachers difficultly learn from each other 3. Teachers always do a practices of teach and learn. 	<ol style="list-style-type: none"> 1. The traditional top-down training method is always for government education political announcement. 2. It is a lack of developed version in permanent education policies.
Threat (T)	<ol style="list-style-type: none"> 1. The school scope is going to develop over-scale size due to the requirement of learning organization. 2. The number of students is always enough in public schools due to cheaper tuition. 	<ol style="list-style-type: none"> 1. Each teacher is not willing to share their lecturing experience and know-how due to the competitive separatism education circumstance. 2. The kinds of teaching training courses are too few to be took and this results in each teach has to fight a lone battle in their lecturing career life.

In succession, making a comprehensive on the “Regulations of On-job Training” for Schools Teachers of Higher, Secondary, Elementary Educations, and Kindergartens” and the “Regulations Governing the Rewards of Teacher Professional Development and Research” in Taiwan, the numerous research and study programs and on-job training courses have been designed from the Taiwanese Ministry of Education because these programs and courses financial patronages have been provided and sponsored by the Taiwanese Ministry of Education. As a result, the contents of these on-job programs and training courses have paid more attention on the government education political announcement which directly results in the majority of teachers have become passive coordinator. Extraordinarily, as the solemn impact of lowest birth rate and the awaking of democratic rights of present Taiwanese society, the majority of senior high school teachers in Taiwan have to not only nurture and then, develop their various anthropocentrism-oriented teaching competences in order to comprehensively provide the suggested solutions for various students’ problems and myths but also assist and then, construct school-based curriculum development for school’s sustainable LO operation (Barth, 1988). Therefore, the Taiwanese Ministry of Education has changed the traditional top-down method to new bottom-up method to design more creative on-job programs and training courses because bottom-up method can provide a series of spontaneous training courses and research and study programs to stimulate the autonomy learning motivation for teachers in order to effectively enhance their TCs for the establishment of sustainable LO development and operation. Specifically, the bottom-up learning characteristic of LO is more suitable for the current teachers to not only simultaneously cultivate their lecturing know-how competency of each teacher by means of organization innovative learning and entire learning research-and-study activities but continuously also to drive the vitality of entire educational institutes. However, beyond making a comprehensive survey on competencies of teachers in Taiwanese senior high schools, there is a few researches to be able to induce the distinctive key factors of teaching competencies in LO by means of empirical surveys.

However, after making comprehensive survey of relative researches on the interplays between Teacher Competence Demands ("TCD") (Field et al., 2000; Field, 2004) and Learning Organization Requests ("LOR") (Cahn, 1992; Busher et al., 2000) for senior high school teachers, there is no research to be able to distinctively evaluate and analyze its dependences and correlations. For the reason, in order to systematically discover the influenced relationship of Technology Education Learning Organization (TELO) in the increment of Teacher's Technology Education Competences (TTEC), this research cross-employs the data refined method of Descriptive Statistics (DS) method and Analysis of Variance (ANOVA) and Principal Components Analysis (PCA) approaches (Bentler & Kano, 1990) of Factor Analysis ("FA") approaches (Fabrigar, Wegener, MacCallum, & Stranhan, 1999) to exhaustively cross-assess empirical teacher's questionnaires of senior high schools in Changhua and Taichung regions in Taiwan from the four brief TCD analytical perspectives, including Individual Demand Competency ("IDC"), Professional Knowledge Competency ("PKC"), Resource Satisfaction Competency ("RSC") and Cooperative Relationship Competency ("CRC") in order to induce the best solution for resupplying academic research gap.

LITERATURE REVIEWS

In consideration of the rapid and opening evolution of Taiwanese education circumstance, TCD and LOR are the two themes to be surveyed in this session. In succession, as for the definition of competence, Hammersley-Fletcher (2002) pointed out competence is supposed to comprehend necessary knowledge, individual value and professional attitude during working processes and Hoult (2004) further supplied the personal potential. Therefore, Hughes (2004) calibrated competence as the internal tangible knowledge skills and techniques and the external intangible self-concept, self-characteristic and self-motivation and then, Gangani and McLean (2006), based on effectivity and efficiency, further categorized competence as (1) basic competence: the standard competence is formed by the entire group members in accordance with organization's version, value and goal; (2) professional competence is necessary for career-request and work-demand in relation with organization targets and decision and (3) individual competence is professional capacity in connection with group development. Furthermore, in extendibility to the Teacher's Competence ("TC"), each teacher desires to be a professional educator with professional TC, not only competent instructors with basic teaching skills because TC is formed through continuous learning and studying for a long time. Kirkham (2004) pointed out TC is supposed to contain teaching conviction, value, role-identification and introspection and Kirby, et al. (2011) distinctively addressed that TC also includes two essential sessions: (1) basic knowledge: knowledge of self and students, knowledge of subject matter and knowledge of educational theory and research and (2) basic abilities: teaching skills and techniques and interpersonal skills. In theoretical, Gay (2000) developed the Teacher Professional Competences Theory ("TPCT") to distinctively define the teacher professional competences is that teachers must have the basic knowledge, cross-subject professional and wild life-experience to be able to not only lecture the necessary subjective and academic knowledge but also provide the best leaded concept and information

for student's various myths. For the reason, there are five explicit teacher's competences categories to be described as (1) curriculum knowledge, (2) general pedagogical knowledge, (3) content knowledge, (4) pedagogical content knowledge and (5) knowledge of learners and their characteristics. Furthermore, Mehaffy (2012) pointed out the current Taiwanese teachers have the two kinds of diversified teaching competencies, academic teaching and individual ability competences in order to confront the miscellaneous student's challenges. These academic teaching competencies (Shulman, 1986) are (1) the fundamental science competences including Chinese, English and Mathematics, (2) the essential social science competences covering history, geography and society research, (3) the necessary academic teaching theory and empirical coaching skill competences and (4) the expertise subjective competence comprehending mastery through a comprehensive study of the subject. Furthermore, as for individual ability competences (Shulman, 1987), these are (1) the teaching situation analytical competence for editing useful teaching materials, (2) the specific teaching method competences for leading students to break through their myths, (3) the technological utilization competence for adopting digital education era and (4) the social relationship competence for establishing cordial relations between teachers and students.

In consideration of OL, Goodlad (1979) clearly defined that organization have to be able to utilize Organization Learning Theory ("OLT") to improve organization efficiency to not only stimulate each member to continuously improve their abilities and capabilities but also institute effective and cooperative groups in order to achieve the organizational goals. Moreover, Glatthorn et al. (2006) directly defined five OL essential characteristics (Spillane, 2005) and these are (1) personal mastery: personal mastery is active power to elaborate member's potential through empirical evaluation as well as construct organizational goals; (2) improving mental models: improving mental models is utilize to integrate constructive comments of the entire members regarding various real situations, including each crisis; (3) building vision: building vision is cooperative and communicated connection between member's concept, thinking and opinions and organizational version, value and culture, (4) team learning: team learning is collective learning behaviors because collective wisdom is always better than individual intelligence and (5) systems thinking: systems thinking's focus full-patterns learning behaviors because the learning impact of each member is apparently influenced on organizational development.

In connection with each specific characteristics of TCD and LOR (Yeung, Irich, Nason, & Glinow, 1999) in the mentioned literatures, the main four analytical perspectives are constructed for comprehensively discuss and inquiry the interplays and dependences between TCD and LOR and these perspectives are (1) IDC covers two individual characters in teaching processes and these are self-transcendence and emotion-control in teaching (Lambert et al., 1996); (2) PKC includes three coaching abilities and these are subject knowledge lecturing, problem-solving techniques and classroom management skills (Lieberman, 1956); (3) RSC



Figure 1. Description of 49 analytical criteria

comprehends two supporting resource in teaching actions and these are teaching resource distribution and school's administrative satisfaction in educational institutions (Lo, 2016) and (4) CRC comprises two relationship development in education behaviors and these are social developing techniques and interflow communication abilities (Lunn & Bishop,2002; Gliniecka, 2016).

Moreover, based on surveyed literatures in self-transcendence and emotion-control, there are 11 assessed criteria to be covered as presented in **Figure 1**.

In explanation with research methodology for assessed measurements, ANOVA and PCA of FA approach are cross-employed to analyze research assessed criteria (Gorsuch, 1990) ANOVA and PCA of FA approach are both form the linear combination of the elucidated percentage of coefficient of variations and it can be expressed as

$$y_1 = w_{j1}x_1 + w_{j2}x_2 + \dots + w_{jm}x_m \tag{1}$$

where y_1 is the first principal component; $m(i = 1, 2, \dots, m)$ is the number of assessed factors; w_{ji} ($w_{j1}^2 + w_{j2}^2 + \dots + w_{jm}^2 = 1$) is the weight-loading of assessed factors.

The variations of principle components are generalized as

$$Var(y_1) = Var(w_{j1}x_1 + w_{j2}x_2 + \dots + w_{jm}x_m) = w_{j1}^2 Var(x_1) + w_{j2}^2 Var(x_2) + \dots + w_{jm}^2 Var(x_m)$$

$$(w_{j1}w_{j2}\dots w_{jm}) \sum [w_{j1}w_{j2}\dots w_{jm}], W^t = (w_{j1}, w_{j2}, \dots, w_{jm})$$

Significantly, when $W_j^2 W_j = 1$, the variations ($Var(y_1) = W_j \sum W_j$) of principle components achieve the maximum and the elucidated percentage of coefficient of variations is also up to the maximum and then, the variations ($Var(y_1) = W_j \sum W_j$) is equal to the characteristics of each assessed factor as $\lambda_j (\lambda_j = \lambda W_j^2 (W_j) = W_j^2 \sum (W_j))$. In statistic, the elucidated percentage of coefficient of variations in first principle component (y_1) is illustrated as $Var(y_1) / \sum_j Var(y_j) = \lambda_1 / \sum_j \lambda_j$ and continuously, elucidated percentage of coefficient of variations in first principle component (y_2) is calculated as $(Var(y_1) + Var(y_2)) / \sum_j Var(y_j) = (\lambda_1 + \lambda_2) / \sum_j \lambda_j$. Ultimately, in order to refine the numbers of assessed factors, the principal components focus on the maximum numbers t to replace the original numbers v in order to induce the most critical elucidated percentage of coefficient of variations as P value is demonstrated as

$$P = Var(y_1) + Var(y_2) + \dots + Var(y_t) / \sum_v^{i=1} Var(y_j) = (\lambda_1 + \lambda_2 + \dots + \lambda_t) / (\lambda_1 + \lambda_2 + \dots + \lambda_v) \tag{2}$$

Based on the research empirical results of ANOVA and PCA of FA approach, McArdle (1990) pointed out that the total number of surveyed data are supposed to be between 100 and 400 because the evaluated standardized errors will affect the assessed results during the surveyed data over 400 and then, Snock and Gorsuch (1989) generalized the dependences

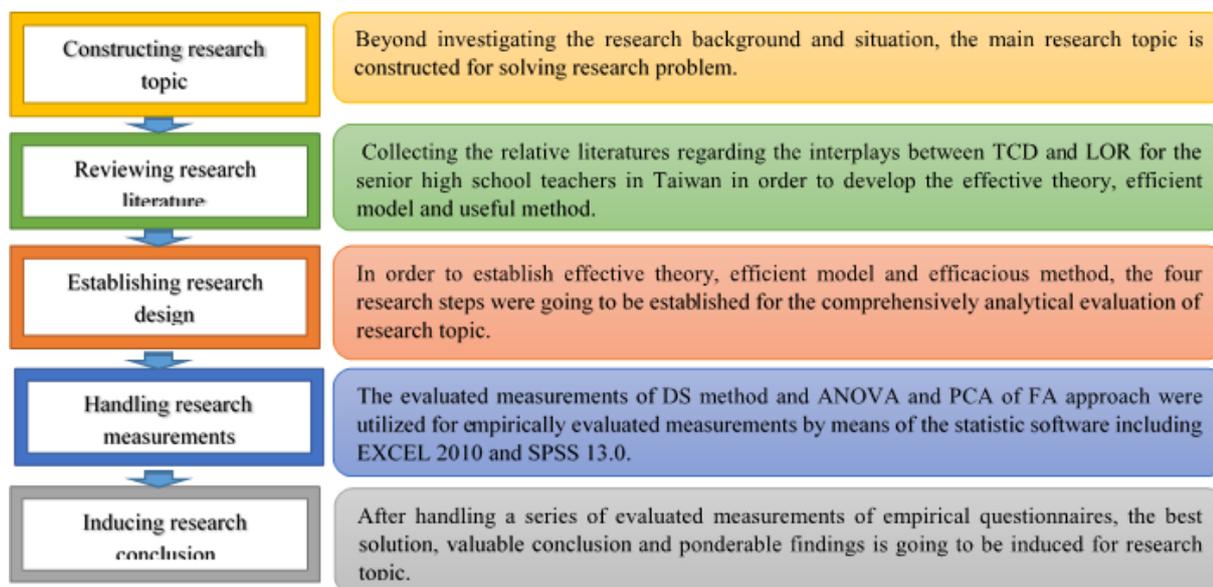


Figure 2. Research Process

between assessed criteria factor loadings of FA approach and the elucidated percentage of coefficient of variations as (1) the elucidated percentage of coefficient of variations is 49% during assessed criteria factor loadings is up to 0.7, (2) the elucidated percentage of coefficient of variations is 64% (over 50%) during assessed criteria factor loadings is 0.8 and (3) the elucidated percentage of coefficient of variations is up to 81% during assessed criteria factor loadings achieves 0.9. Eventually, Widamam (1993) definitely addressed the versified principle that ANOVA and PCA of FA approach is suitable for surveyed samples if the KMO testified score must be bigger than 0.7 and the significance P value of Bartlett's globular verification is simultaneously lower than 0.005 (Hair, Anderson, Tathan, & Black, 1998).

RESEARCH DESIGN

Research Process

In order to efficiently explore learning community intention and the needs of expertise for the senior high Schools, this research adopts the five procedures in research process as expresses in **Figure 2** and these research procedures are (1) constructing research topic, (2) reviewing research literature, (3) establishing research design, (4) handling research measurements and (5) inducing research conclusion.

Research surveyed data

The 450 questionnaires randomly were collected from teachers of senior high schools in the regions of Changhua and Taichung in Taiwan and then, only 423 of 450 interviewed questionnaires were returned which means rate of return reaches 94%. After further checking the 423 collected questionnaires, there are some incomplete and data in 21 returned questionnaire and as a result, the validate questionnaires are 402 which means rate of return

Table 2. Descriptive statistic of interviewees

Questionnaires surveyed place	The number of validate interviewees
city districts in Changhua region	130
suburban districts in Changhua region	126
city districts in Taichung region	77
suburban districts in Taichung region	69
Total	402

in validate questionnaire was up to 95.04 %. The details of interviewees of teachers in senior high schools in Taiwan is expressed in **Table 2**.

RESEARCH MEASUREMENTS

In this session, the evaluated measurements were calculated by means of (1) and (2) equations of ANOVA and PCA of FA from the four brief analytical perspectives.

First step - evaluated measurements of IDC

There are 11 of 49 evaluated criteria to be belonged in response with the assessed measurements of IDC. Not only KMO-test score of IDC of interviewed teachers in senior high schools in two districts in Changhua and Taichung regions are 0.774, 0.775, 0.898 and 0.803 which are higher than 0.7 but also the significance test scores of two districts in Changhua and Taichung regions are both $0.0000 < \alpha$ which is lower than 0.05 which means ANOVA and PCA of FA approaches are suitable for IDC assessed measurements. Subsequently, the four eigenvalues (Eigenvalue λ) (Eigenvalue $\lambda_1=4.129$, Eigenvalue $\lambda_2=1.308$ and Eigenvalue $\lambda_3=1.252$) of IDC assessed measurements in suburban districts in Changhua region are bigger than 1. Hence, these are three assessed criteria to be considered as TCDs. For the reason, the definitions of three critical TCD are "improving reading abilities to stimulate individual potentiality", "obtaining teaching achievement to gather individual happiness" and "catching more information to match current tendency". In succession, the explanatory coefficient of variation percentage of first determinant is $37.54\% \left(\frac{\lambda_1}{\sum_{i=1}^{11} \lambda_i} = \frac{4.126}{11} = 0.3754 \right)$, second determinant is $11.89\% \left(\frac{\lambda_2}{\sum_{i=1}^{11} \lambda_i} = \frac{1.308}{11} = 0.1189 \right)$, third determinant is $11.38\% \left(\frac{\lambda_3}{\sum_{i=1}^{11} \lambda_i} = \frac{1.252}{11} = 0.1138 \right)$ and total three determinants is up to $60.81\% \left(\frac{(\lambda_1+\lambda_2+\lambda_3)}{\sum_{i=1}^{11} \lambda_i} = \frac{(4.129+1.308+1.252)}{11} = 0.6081 \right)$, which is the most closed to 70%.

However, as for the eigenvalues (Eigenvalue λ) of interviewed teachers in senior high schools in city district in Changhua region, there are four eigenvalues (Eigenvalue λ) (Eigenvalue $\lambda_1 = 4.129$, Eigenvalue $\lambda_2=1.308$, Eigenvalue $\lambda_3=1.252$ and Eigenvalue $\lambda_4=1.042$) to be bigger than 1. Thus, the forth TCD is able to define as "cultivating best reading habit to catch more information". Then, the explanatory coefficient of variation percentage of first determinant is $38.33\% \left(\frac{\lambda_1}{\sum_{i=1}^{11} \lambda_i} = \frac{4.216}{11} = 0.3833 \right)$, second determinant is $14.33\% \left(\frac{\lambda_2}{\sum_{i=1}^{11} \lambda_i} = \right)$

$\frac{1.576}{11} = 0.1433$), third determinant is 9.69% $\left(\frac{\lambda_3}{\sum_{i=1}^{11} \lambda_i} = \frac{1.066}{11} = 0.0969\right)$, fourth determinant is 9.47% $\left(\frac{\lambda_4}{\sum_{i=1}^{11} \lambda_i} = \frac{1.042}{11} = 0.0947\right)$ and total four determinants is up to 71.82% $\left(\frac{(\lambda_1 + \lambda_2 + \lambda_3 + \lambda_4)}{\sum_{i=1}^{11} \lambda_i} = \frac{(4.216 + 1.576 + 1.066 + 1.042)}{11} = 0.7182\right)$, which is the most closed to 70%.

Continuously, eigenvalues (Eigenvalue λ) of IDC assessed measurements of suburban districts in Taichung region, only two eigenvalues (Eigenvalue λ) (Eigenvalue $\lambda_1 = 5.82$ and Eigenvalue $\lambda_2 = 1.549$) are bigger than 1 and therefore, these two assessed criteria are considered as TCDs. Successively, the definitions of these two TCDs are able to express as "changing emotional pleasure to stimulate potential satisfaction" and "urging self to cultivate stable reading habit". In succession, the explanatory coefficient of variation percentage of first determinant is 52.91% $\left(\frac{\lambda_1}{\sum_{i=1}^{11} \lambda_i} = \frac{5.82}{11} = 0.5291\right)$, second determinant is 14.08% $\left(\frac{\lambda_2}{\sum_{i=1}^{11} \lambda_i} = \frac{1.549}{11} = 0.1408\right)$ and total two determinants is up to 66.99% $\left(\frac{(\lambda_1 + \lambda_2)}{\sum_{i=1}^{11} \lambda_i} = \frac{(5.82 + 1.549)}{11} = 0.6699\right)$, which is the most closed to 70%. Nevertheless in sight of the eigenvalues (Eigenvalue λ) of interviewed teachers in senior high schools in city district in Taichung region, there are three eigenvalues (Eigenvalue λ) (Eigenvalue $\lambda_1 = 4.36$, Eigenvalue $\lambda_2 = 1.963$ and Eigenvalue $\lambda_3 = 1.048$) to be bigger than 1. Thereat, the third TCD is able to describe as "increasing current-tendency information to obtain identification". Moreover, the explanatory coefficient of variation percentage of first determinant is 39.69% $\left(\frac{\lambda_1}{\sum_{i=1}^{11} \lambda_i} = \frac{4.36}{11} = 0.3969\right)$, second determinant is 17.84% $\left(\frac{\lambda_2}{\sum_{i=1}^{11} \lambda_i} = \frac{1.963}{11} = 0.1784\right)$, third determinant is 9.53% $\left(\frac{\lambda_3}{\sum_{i=1}^{11} \lambda_i} = \frac{1.048}{11} = 0.0953\right)$ and total four determinants is up to 67% $\left(\frac{(\lambda_1 + \lambda_2 + \lambda_3)}{\sum_{i=1}^{11} \lambda_i} = \frac{(4.36 + 1.963 + 1.048)}{11} = 0.67\right)$, which is the most closed to 70%.

Second step -evaluated measurements of PKC

There are also 11 of 49 evaluated criteria to be belonged in response with the assessed measurements of PKC. Not only KMO-test score of PKC of interviewed teachers in senior high schools in two districts in Changhua and Taichung regions are 0.718, 0.755, 0.902 and 0.794 which are higher than 0.7 but also the significance test scores of two districts in Changhua and Taichung regions are both $0.0000 < \alpha$ which is lower than 0.05 which means the ANOVA and PCA of FA approaches are suitable for PKC assessed measurements. Subsequently, the five eigenvalues (Eigenvalue λ) (Eigenvalue $\lambda_1 = 3.388$, Eigenvalue $\lambda_2 = 1.873$, Eigenvalue $\lambda_3 = 1.367$, Eigenvalue $\lambda_4 = 1.284$ and Eigenvalue $\lambda_5 = 1.143$) of PKC assessed criteria of suburban districts in Changhua region are bigger than 1 which means these five assessed criteria are considered as TCDs. For the reason, the definitions of these five TCDs are "strengthening teaching subject-knowledge and professional-skills", "increasing personal leadership and student's reliance", "improving personal reading technique", "enforcing classroom-management ability" and "adding the cross-subject knowledge". Besides, the explanatory coefficient of variation

percentage of first determinant is 30.8% $\left(\frac{\lambda_1}{\sum_{i=1}^{11} \lambda_i} = \frac{3.388}{11} = 0.308\right)$, second determinant is 17.03% $\left(\frac{\lambda_2}{\sum_{i=1}^{11} \lambda_i} = \frac{1.873}{11} = 0.1703\right)$, third determinant is 12.43% $\left(\frac{\lambda_3}{\sum_{i=1}^{11} \lambda_i} = \frac{1.367}{11} = 0.1243\right)$, fourth determinant is 11.67% $\left(\frac{\lambda_4}{\sum_{i=1}^{11} \lambda_i} = \frac{1.284}{11} = 0.1167\right)$, fifth determinant is 10.39% $\left(\frac{\lambda_5}{\sum_{i=1}^{11} \lambda_i} = \frac{1.143}{11} = 0.1039\right)$, and total five determinants reaches 82.32% $\left(\frac{(\lambda_1+\lambda_2+\lambda_3+\lambda_4+\lambda_5)}{\sum_{i=1}^{11} \lambda_i} = \frac{(3.388+1.873+1.367+1.284+1.143)}{11} = 0.8232\right)$, which is the most closed to 70%.

Nevertheless, only four eigenvalues (Eigenvalue λ) of interviewed teachers in senior high schools in city district in Changhua region are bigger than 1 because the third TCD, “improving personal reading technique”, is not obviously positive correlation in PKC assessed measurements. Successively, the explanatory coefficient of variation percentage of first determinant is 38.38% $\left(\frac{\lambda_1}{\sum_{i=1}^{11} \lambda_i} = \frac{4.222}{11} = 0.3838\right)$, of second determinant is 13.72% $\left(\frac{\lambda_2}{\sum_{i=1}^{11} \lambda_i} = \frac{1.51}{11} = 0.1372\right)$, of third determinant is 10.95% $\left(\frac{\lambda_3}{\sum_{i=1}^{11} \lambda_i} = \frac{1.205}{11} = 0.1095\right)$ of fourth determinant is 9.16% $\left(\frac{\lambda_4}{\sum_{i=1}^{11} \lambda_i} = \frac{1.008}{11} = 0.0916\right)$, and total four determinants is up to 72.2% $\left(\frac{(\lambda_1+\lambda_2+\lambda_3+\lambda_4)}{\sum_{i=1}^{11} \lambda_i} = \frac{(4.222+1.51+1.205+1.008)}{11} = 0.722\right)$ which is the most closed to 70%. Crucially, only two eigenvalues (Eigenvalue λ) (Eigenvalue $\lambda_1=6.452$ and Eigenvalue $\lambda_2= 1.05$) in PKC assessed measurements of suburban districts in Taichung region are bigger than 1. Therefore, these two assessed criteria are able to be considered as TCDs and these are “increasing various subjects reading to earn student’s persuasiveness” and “enhancing cross-subject professional knowledge to acquire comprehensive teaching abilities”. In succession, the explanatory coefficient of variation percentage of first determinant is 58.65% $\left(\frac{\lambda_1}{\sum_{i=1}^{11} \lambda_i} = \frac{6.452}{11} = 0.5865\right)$, and second determinant is 9.6% $\left(\frac{\lambda_2}{\sum_{i=1}^{11} \lambda_i} = \frac{1.056}{11} = 0.096\right)$, and total two determinants achieves 68.3% $\left(\frac{(\lambda_1+\lambda_2)}{\sum_{i=1}^{11} \lambda_i} = \frac{(6.452+1.056)}{11} = 0.683\right)$, which is the most closed to 70%. Notwithstanding, in consideration of the eigenvalues (Eigenvalue λ) of interviewed teachers in senior high schools in city district in Taichung region, there are three eigenvalues (Eigenvalue λ) (Eigenvalue $\lambda_1=4.758$, Eigenvalue $\lambda_2=1.276$ and Eigenvalue $\lambda_3=1.175$) to be bigger than 1. Thereat, the third TCD is defined as “focusing on empirical teaching technique to increase the knowledge lecture”. Then, the explanatory coefficient of variation percentage of first determinant is 43.25% $\left(\frac{\lambda_1}{\sum_{i=1}^{11} \lambda_i} = \frac{4.758}{11} = 0.4326\right)$, second determinant is 11.6% $\left(\frac{\lambda_2}{\sum_{i=1}^{11} \lambda_i} = \frac{1.276}{11} = 0.116\right)$, third determinant is 10.68% $\left(\frac{\lambda_3}{\sum_{i=1}^{11} \lambda_i} = \frac{1.175}{11} = 0.1068\right)$, and total three determinants is up to 66% $\left(\frac{(\lambda_1+\lambda_2+\lambda_3)}{\sum_{i=1}^{11} \lambda_i} = \frac{(4.758+1.276+1.175)}{11} = 0.66\right)$ which is the most closed to 70%.

Third step – evaluated measurements of RSC

There are 16 of 46 evaluated criteria to be belonged in response with the assessed measurements of RSC. Not only KMO-test score of RSC of interviewed teachers in senior high schools in two districts in Changhua and Taichung regions are 0.743, 0.81, 0.844 and 0.769 which are higher than 0.7 but also the significance test scores are both $0.0000 < \alpha$ which is lower than 0.05 which means the ANOVA and PCA of FA approaches are suitable for RSC assessed measurements. Subsequently, the eigenvalues (Eigenvalue λ) of five RSC assessed criteria (Eigenvalue $\lambda_1=3.91$, Eigenvalue $\lambda_2=2.544$, Eigenvalue $\lambda_3=1.638$, Eigenvalue $\lambda_4=1.407$ and Eigenvalue $\lambda_5=1.173$) are bigger than 1 and therefore, these five assessed criteria are considered as TCDs of RSC assessed measurements of suburban districts in Changhua region. For the reason, the definitions of five TCDs are “government policies and administration to encourage internet learning certification”, “appropriate utilization of school’s resource to improve the school’s reputation”, “the sponsors from non-governmental organizations to strengthen school’s resource capabilities”, “the proper interactive relationship to promote teacher’s positive images” and “the increment of interaction with professionals to cohere teacher’s consciousness”. Subsequently, the explanatory coefficient of variation percentage of first determinant is 24.4% $\left(\frac{\lambda_1}{\sum_{i=1}^{16} \lambda_i} = \frac{3.91}{16} = 0.244\right)$, second determinant is 15.9% $\left(\frac{\lambda_2}{\sum_{i=1}^{16} \lambda_i} = \frac{2.544}{16} = 0.159\right)$, third determinant is 10.24% $\left(\frac{\lambda_3}{\sum_{i=1}^{16} \lambda_i} = \frac{1.638}{16} = 0.1024\right)$, fourth determinant is 8.79% $\left(\frac{\lambda_4}{\sum_{i=1}^{16} \lambda_i} = \frac{1.407}{16} = 0.0879\right)$, fifth determinant is 7.33% $\left(\frac{\lambda_5}{\sum_{i=1}^{16} \lambda_i} = \frac{1.173}{16} = 0.0733\right)$, and total five determinants reaches 66.7% $\left(\frac{(\lambda_1+\lambda_2+\lambda_3+\lambda_4+\lambda_5)}{\sum_{i=1}^{16} \lambda_i} = \frac{(3.91+2.544+1.638+1.407+1.173)}{16} = 0.667\right)$ which is most closed to 70%. Particularly, there are also five eigenvalues (Eigenvalue λ) (Eigenvalue $\lambda_1=5.808$, Eigenvalue $\lambda_2=1.831$, Eigenvalue $\lambda_3=1.33$, Eigenvalue $\lambda_4=1.068$ and Eigenvalue $\lambda_5=1.007$) of interviewed teachers in senior high schools in city district in Changhua region to be bigger than 1. Apparently, the explanatory coefficient of variation percentage of first determinant is 36.3% $\left(\frac{\lambda_1}{\sum_{i=1}^{16} \lambda_i} = \frac{5.808}{16} = 0.363\right)$, second determinant is 11.44% $\left(\frac{\lambda_2}{\sum_{i=1}^{16} \lambda_i} = \frac{1.831}{16} = 0.1144\right)$, third determinant is 8.31% $\left(\frac{\lambda_3}{\sum_{i=1}^{16} \lambda_i} = \frac{1.33}{16} = 0.0831\right)$, fourth determinant is 6.67% $\left(\frac{\lambda_4}{\sum_{i=1}^{16} \lambda_i} = \frac{1.068}{16} = 0.0667\right)$, fifth determinant is 6.3% $\left(\frac{\lambda_5}{\sum_{i=1}^{16} \lambda_i} = \frac{1.007}{16} = 0.063\right)$, and total five determinants reaches 69% $\left(\frac{(\lambda_1+\lambda_2+\lambda_3+\lambda_4+\lambda_5)}{\sum_{i=1}^{16} \lambda_i} = \frac{(5.808+1.831+1.33+1.068+1.007)}{16} = 0.69\right)$ which is most closed to 70%. Continuously, the four eigenvalues (Eigenvalue λ) (Eigenvalue $\lambda_1=7.033$, Eigenvalue $\lambda_2=1.404$, Eigenvalue $\lambda_3=1.373$ and Eigenvalue $\lambda_4=1.031$) of RSC assessed measurements of suburban districts in Taichung region are bigger than 1 and thereat, these four assessed criteria are able to demonstrate as TCDs. Successively, the definitions of these four TCDs are “proper utilization of school’s resource to effectively enhance school’s professional reputation”, “the sponsors from non-governmental organizations to provide more teacher’s on-job programs and courses”, “proper utilization of school’s resource to

efficiently strengthen teacher's professional images" and "the supporting from school's administration to establish official certification of internet training programs". Successively, the explanatory coefficient of variation percentage of first determinant is 43.97% $\left(\frac{\lambda_1}{\sum_{i=1}^{16} \lambda_i} = \frac{7.033}{16} = 0.4397\right)$, second determinant is 8.77% $\left(\frac{\lambda_2}{\sum_{i=1}^{16} \lambda_i} = \frac{1.404}{16} = 0.0877\right)$, third determinant is 8.58% $\left(\frac{\lambda_3}{\sum_{i=1}^{16} \lambda_i} = \frac{1.373}{16} = 0.0858\right)$, fourth determinant is 6.44% $\left(\frac{\lambda_4}{\sum_{i=1}^{16} \lambda_i} = \frac{1.031}{16} = 0.0644\right)$, and total four determinants reaches 67.8% $\left(\frac{(\lambda_1+\lambda_2+\lambda_3+\lambda_4)}{\sum_{i=1}^{16} \lambda_i} = \frac{(7.033+1.404+1.373+1.031)}{16} = 0.678\right)$ which is the most closed to 70%. Specifically, in accordance with the eigenvalues (Eigenvalue λ) of interviewed teachers in senior high schools in city district in Taichung region, there are five eigenvalues (Eigenvalue λ) (Eigenvalue $\lambda_1=5.117$, Eigenvalue $\lambda_2=1.962$, Eigenvalue $\lambda_3=1.801$, Eigenvalue $\lambda_4=1.276$ and Eigenvalue $\lambda_5=1.035$) to be bigger than 1. Continuously, the fifth TCD is able to depict as "the school's encouraging policies to invite professionals to schools for empirical interchange". Thus, the explanatory coefficient of variation percentage of first determinant is 31.98% $\left(\frac{\lambda_1}{\sum_{i=1}^{16} \lambda_i} = \frac{5.117}{16} = 0.3198\right)$, second determinant is 12.26% $\left(\frac{\lambda_2}{\sum_{i=1}^{16} \lambda_i} = \frac{1.962}{16} = 0.1226\right)$, third determinant is 11.26% $\left(\frac{\lambda_3}{\sum_{i=1}^{16} \lambda_i} = \frac{1.801}{16} = 0.1126\right)$, fourth determinant is 7.97% $\left(\frac{\lambda_4}{\sum_{i=1}^{16} \lambda_i} = \frac{1.276}{16} = 0.0797\right)$, fifth determinant is 6.5% $\left(\frac{\lambda_5}{\sum_{i=1}^{16} \lambda_i} = \frac{1.035}{16} = 0.065\right)$, and total five determinants reaches 70% $\left(\frac{(\lambda_1+\lambda_2+\lambda_3+\lambda_4+\lambda_5)}{\sum_{i=1}^{16} \lambda_i} = \frac{(5.117+1.962+1.801+1.276+1.035)}{16} = 0.7\right)$ which is exactly equal with 70%.

Fourth step - evaluated measurements of CRC

There are also 11 of 49 evaluated criteria to be belonged in response with the assessed measurements of CRC. Not only KMO-test score of CRC of interviewed teachers in senior high schools in two districts in Changhua and Taichung regions are 0.735, 0.804, 0.844 and 0.778 which are higher than 0.7 but also the significance test scores of two districts in Changhua and Taichung regions are both $0.0000 < \alpha$ which is lower than 0.05 which means the ANOVA and PCA of FA approaches are suitable for CRC assessed measurements. Subsequently, the four eigenvalues (Eigenvalue λ) (Eigenvalue $\lambda_1=2.92$, Eigenvalue $\lambda_2=1.795$, Eigenvalue $\lambda_3=1.383$ and Eigenvalue $\lambda_4=1.059$) of CRC assessed criteria of suburban districts in Changhua region are bigger than 1 which means these four assessed criteria are considered as TCDs. Therefore, the definitions of these four TCDs are "attaining supporting from cooperative academic teaching teams", "intensifying representing ability to improve cooperative relationship", "expanding cooperative members to inquire life experience" and "obtaining the leadership from professionals and experts". Furthermore, the explanatory coefficient of variation percentage of first determinant is 26.55% $\left(\frac{\lambda_1}{\sum_{i=1}^{11} \lambda_i} = \frac{2.92}{11} = 0.2655\right)$, second determinant is 16.32% $\left(\frac{\lambda_2}{\sum_{i=1}^{11} \lambda_i} = \frac{1.795}{11} = 0.1632\right)$, third determinant is 12.57% $\left(\frac{\lambda_3}{\sum_{i=1}^{11} \lambda_i} = \frac{1.383}{11} = 0.1257\right)$, fourth

determinant is 9.63% $\left(\frac{\lambda_4}{\sum_{i=1}^{11} \lambda_i} = \frac{1.284}{11} = 0.0963\right)$, and total five determinants reaches 65% $\left(\frac{(\lambda_1+\lambda_2+\lambda_3+\lambda_4)}{\sum_{i=1}^{11} \lambda_i} = \frac{(2.92+1.795+1.383+1.059)}{11} = 0.65\right)$ which is the most closed to 70%.

Nevertheless, only three eigenvalues (Eigenvalue λ) (Eigenvalue $\lambda_1=4.23$, Eigenvalue $\lambda_2=1.894$, Eigenvalue $\lambda_3=1.383$ and Eigenvalue $\lambda_4=1.006$) of CRC assessed criteria of interviewed teachers in senior high schools in city district in Changhua region are bigger than 1 because the forth TCD, "obtaining the leadership from professionals and experts", is not apparently positive correlation in CRC assessed measurements. Successively, the explanatory coefficient of variation percentage of first determinant is 38.45% $\left(\frac{\lambda_1}{\sum_{i=1}^{11} \lambda_i} = \frac{4.23}{11} = 0.3845\right)$, of second determinant is 17.22% $\left(\frac{\lambda_2}{\sum_{i=1}^{11} \lambda_i} = \frac{1.894}{11} = 0.1722\right)$, of third determinant is 9.15% $\left(\frac{\lambda_3}{\sum_{i=1}^{11} \lambda_i} = \frac{1.006}{11} = 0.0915\right)$, and total three determinants is up to 64.8% $\left(\frac{(\lambda_1+\lambda_2+\lambda_3)}{\sum_{i=1}^{11} \lambda_i} = \frac{(4.23+1.894+1.006)}{16} = 0.648\right)$ which is the most closed to 70%. Continuously, there are three eigenvalues (Eigenvalue λ) (Eigenvalue $\lambda_1=5.019$, Eigenvalue $\lambda_2=1.216$ and Eigenvalue $\lambda_3=1.052$) in CRC assessed measurements of suburban districts in Taichung region are bigger than 1. Therefore, these three assessed criteria are able to be considered as TCDs and these are "attaining various group supporting to get leadership", "enhancing expressing ability to expand life dimensions" and "attending comprehensive groups to obtain cooperative relationships". Moreover, the explanatory coefficient of variation percentage of first determinant is 45.63% $\left(\frac{\lambda_1}{\sum_{i=1}^{11} \lambda_i} = \frac{5.019}{11} = 0.4563\right)$, second determinant is 11.05% $\left(\frac{\lambda_2}{\sum_{i=1}^{11} \lambda_i} = \frac{1.216}{11} = 0.1105\right)$, third determinant is 9.6% and total three determinants achieves 66.2% $\left(\frac{(\lambda_1+\lambda_2+\lambda_3)}{\sum_{i=1}^{11} \lambda_i} = \frac{(5.019+1.216+1.052)}{16} = 0.662\right)$ which is the most closed to 70%. In consideration of the eigenvalues (Eigenvalue λ) of interviewed teachers in senior high schools in city district in Taichung region, there are also three eigenvalues (Eigenvalue λ) (Eigenvalue $\lambda_1=3.948$, Eigenvalue $\lambda_2=1.366$ and Eigenvalue $\lambda_3=1.089$) to be bigger than 1. Thus the explanatory coefficient of variation percentage of first determinant is 35.89% $\left(\frac{\lambda_1}{\sum_{i=1}^{11} \lambda_i} = \frac{3.948}{11} = 0.3589\right)$, second determinant is 12.42% $\left(\frac{\lambda_2}{\sum_{i=1}^{11} \lambda_i} = \frac{1.366}{11} = 0.1242\right)$, third determinant is 9.9% $\left(\frac{\lambda_3}{\sum_{i=1}^{11} \lambda_i} = \frac{1.089}{11} = 0.099\right)$, and total three determinants is up to 58.2%

$\left(\frac{(\lambda_1+\lambda_2+\lambda_3)}{\sum_{i=1}^{11} \lambda_i} = \frac{(3.948+1.366+1.089)}{16} = 0.582\right)$ which is the most closed to 70%. Consequently, the assessed measurement comparisons of the four brief analytical perspectives are distinctively expressed as **Table 3**.

Table 3. Assessed measurement comparisons of the four brief analytical perspectives

Questionnaires surveyed place	suburban districts in Changhua region	city districts in Changhua region	suburban districts in Taichung region	city districts in Taichung region
IDC assessed measurements	<ol style="list-style-type: none"> 1. improving reading abilities to stimulate individual potentiality 2. obtaining teaching achievement to gather individual happiness 3. catching more information to match current tendency 	<ol style="list-style-type: none"> 1. improving reading abilities to stimulate individual potentiality 2. obtaining teaching achievement to gather individual happiness 3. catching more information to match current tendency 4. cultivating best reading habit to catch more information 	<ol style="list-style-type: none"> 1. changing emotional pleasure to stimulate potential satisfaction 2. urging self to cultivate stable reading habit 	<ol style="list-style-type: none"> 1. changing emotional pleasure to stimulate potential satisfaction 2. urging self to cultivate stable reading habit 3. increasing current-tendency information to obtain identification
PKC assessed measurements	<ol style="list-style-type: none"> 1. strengthening teaching subject-knowledge and professional-skills 2. increasing personal leadership and student's reliance 3. improving personal reading technique 4. enforcing classroom-management ability 5. adding the cross-subject knowledge 	<ol style="list-style-type: none"> 1. strengthening teaching subject-knowledge and professional-skills 2. increasing personal leadership and student's reliance 3. enforcing classroom-management ability 4. adding the cross-subject knowledge 	<ol style="list-style-type: none"> 1. increasing various subjects reading to earn student's persuasiveness 2. enhancing cross-subject professional knowledge to acquire comprehensive teaching abilities 	<ol style="list-style-type: none"> 1. increasing various subjects reading to earn student's persuasiveness 2. enhancing cross-subject professional knowledge to acquire comprehensive teaching abilities 3. focusing on empirical teaching technique to increase the knowledge lecture

Table 3. Assessed measurement comparisons of the four brief analytical perspectives (*continued*)

Questionnaires surveyed place	suburban districts in Changhua region	city districts in Changhua region	suburban districts in Taichung region	city districts in Taichung region
RSC assessed measurements	<ol style="list-style-type: none"> 1. government policies and administration to encourage internet learning certification 2. appropriate utilization of school's resource to improve the school's reputation 3. the sponsors from non-governmental organizations to strengthen school's resource capabilities 4. the proper interactive relationship to promote teacher's positive images 5. the increment of interaction with professionals to cohere teacher's consciousness 	<ol style="list-style-type: none"> 1. government policies and administration to encourage internet learning certification 2. appropriate utilization of school's resource to improve the school's reputation 3. the sponsors from non-governmental organizations to strengthen school's resource capabilities 4. the proper interactive relationship to promote teacher's positive images 5. the increment of interaction with professionals to cohere teacher's consciousness 	<ol style="list-style-type: none"> 1. proper utilization of school's resource to effectively enhance school's professional reputation 2. the sponsors from non-governmental organizations to provide more teacher's on-job programs and courses 3. proper utilization of school's resource to efficiently strengthen teacher's professional images 4. the supporting from school's administration to establish official certification of internet training programs 	<ol style="list-style-type: none"> 1. proper utilization of school's resource to effectively enhance school's professional reputation 2. the sponsors from non-governmental organizations to provide more teacher's on-job programs and courses 3. proper utilization of school's resource to efficiently strengthen teacher's professional images 4. the supporting from school's administration to establish official certification of internet training programs 5. the school's encouraging policies to invite professionals to schools for empirical interchange

Table 3. Assessed measurement comparisons of the four brief analytical perspectives (*continued*)

Questionnaires surveyed place	suburban districts in Changhua region	city districts in Changhua region	suburban districts in Taichung region	city districts in Taichung region
CRC assessed measurements	1. attaining supporting from cooperative academic teaching teams 2. intensifying representing ability to improve cooperative relationship 3. expanding cooperative members to inquire life experience 4. obtaining the leadership from professionals and experts	1. attaining supporting from cooperative academic teaching teams 2. intensifying representing ability to improve cooperative relationship 3. expanding cooperative members to inquire life experience	1. attaining various group supporting to get leadership 2. enhancing expressing ability to expand life dimensions 3. attending comprehensive groups to obtain cooperative relationships	1. attaining various group supporting to get leadership 2. enhancing expressing ability to expand life dimensions 3. attending comprehensive groups to obtain cooperative relationships

CONCLUSION

In sight of the induced results in **Table 3**, the four contributive conclusions are demonstrated as

- (1) According to the comprehensive comparisons in IDC assessed measurements, the majority of teachers desire to cultivate reading competency for catching more professional information and matching current tendency in order to satisfy their individual achievement.
- (2) As for the horizontal comparisons in PKC assessed measurements, the numerous teachers focus on strengthening cross-subjects and empirical teaching competencies for classroom management in lecturing processes in order to increase personal leadership and student’s reliance.
- (3) In view of the various comparisons in RSC assessed measurements, the plurality of teachers expect to enhance convincing competency to attain school’s resource and administrative supporting and non-governmental organizations sponsoring for obtaining more empirical and internet on-job and training certificate programs and license courses in order to enhance school’s professional reputation teacher’s professional images.

- (4) In sight of the exhaustive comparisons in CRC assessed measurements, the mass of teachers aspire to foster cooperative competency for attaining team supporting and cooperation from each other and professional and academic groups in order to gather leadership and expand cooperative members to inquire life experiences.

Based on the results of complex evaluated measurements, the four most decisive TCDs for constructing the potential LOR are “reading competency for IDC”, “cross-subjects and empirical teaching competencies for PKC”, “convincing competency for RSC” and “cooperative competency” which is the most ponderable contribution of this research. Furthermore, in order to survive in the lowest birth-rate and highest democratic-rights education era, Taiwanese senior high schools must concretely put more school’s administrative resource and aggressively collect more sponsoring from non-for-profit education organizations and governmental education departments to provide a series of empirical and digital on-job certificate programs and training license courses to assist teachers to nurture these most critical TCDs including reading, cross-subjects and empirical teaching, convincing and cooperative. Furthermore, the most ponderable findings is to effectively decrease the impact of the lowest birth-rate and the requests of highest democratic-rights on education, Taiwanese senior high schools must not only provide their schools administrative resource but also collect the supporting and sponsoring of government education departments and non-for-profit education organizations for instituting a series of empirical on-job certificate programs and digital training license courses. This is able to assist these teachers to nurture the most critical TCDs (Hsieh & Chan, 2016), including reading, cross-subjects and empirical teaching, convincing and cooperative competencies, for construct school’s aggressive vision, core value and sustainable brand. Though this paper collection questionnaires from 450 random interviewees, there are still need more participators to be surveyed in the further future research. Specifically, the ponderable findings of this paper to re-supply research gap in relative TCD and LOR research fields, the “reading competency for IDC”, “cross-subjects and empirical teaching competencies for PKC”, “convincing competency for RSC” and “cooperative competency” are the most decisive TCDs for completely constructing the most potential LORs for the current Taiwanese senior high school teachers in the lowest birth-rate and highest democratic-rights education era.

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APPENDICES

Appendix 1

Terms and Abbreviations

Terms	Abbreviations
Teacher's Competence	TC
the Teacher Professional Competences Theory	TPCT
Learning Organization	LO
Organization Learning Theory	OLT
Teacher Competence Demands and Learning Organization Requests	TCD LOR
Descriptive Statistics method	DS
Analysis of Variance	ANOVA
Principal Components Analysis	PCA
Factor Analysis FA approaches	FA
Individual Demand Competency	IDC
Professional Knowledge Competency	PKC
Resource Satisfaction Competency	RSC
Cooperative Relationship Competency	CRC

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