Measurement of Coupling Coordination Between Vocational Happiness and Affective Education Ability of Young Teachers

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Abstract—When teachers are giving affective education, their emotional communication with students is a kind of state or process during which teachers' work pressure can be alleviated when they are cultivating students' sentiment, in the meantime, they also could attain positive mental quality and a sense of vocational happiness. Regarding the relationship between young teachers' vocational happiness and their Affective Education Ability (AEA), only 1–2 articles have discussed it from the perspective of a single ability, there isn't complete research on the AEA system of teachers. Therefore, to fill in this research blank, this paper aims to measure the coupling and coordination between the development of young teachers' vocational happiness and their AEA, in the hopes of providing a piece of useful evidence for relevant research. The theory of emotional intelligence and positive psychology serve as the theoretical basis of this paper. In the second chapter, this paper builds a framework for young teachers' affective education and an AEA training model, and employs Artificial Neural Network (ANN) to extract the time series data features of the divided six evaluation indexes of young teachers' AEA. In the third chapter, this paper uses the Coupling Coordination Degree (CCD) to measure the coupling and coordination of the development level young teachers' vocational happiness and their six kinds of AEA, and gives the quantification process. In the fourth chapter, this paper adopts the Grey Relational Analysis (GRA) to quantify the influence degree of all indexes on young teachers' vocational happiness and their six kinds of AEA, thereby realizing the quantitative measurement of each evaluation index on the comprehensive development of the two. At last, experimental results are drawn to verify the measurement and analysis results of the coupling and coordination of the two.

Keywords—young teacher, vocational happiness, affective education, coupling coordination

1 Introduction

As the philosophy of education is being constantly updated with the reform progress of education system, now educationalists have paid more attention to students' values on sentiment attitudes and new social abilities [1–7]. Affective education can help students develop emotional habits and have a healthy mental state, which is very meaningful for cultivating students' social adaptability and interpersonal skills in the future [8–17]. Teachers with a higher-level of AEA could have a better emotional connection with students, and such emotional connection or communication can be defined as a state or a process during which the teachers' work pressure can be alleviated when they are cultivating students' sentiment, in the meantime, the teachers can also attain positive mental quality and a sense of vocational happiness [18–21].

Post et al. [22] reviewed remote labs in higher education and empirically examined the learning benefits of such labs. Their paper aimed at the effects of the learning results of cognitions, behaviors, and affections. In general, the research findings suggest that the positive outcomes of these three kinds of learning results are that students have acquired conceptual knowledge, participated in the lab activities, and are satisfied with the learning in a remote lab environment. Despeisse [23] pointed out that gamification and experiential learning are becoming more and more popular in education since they could create an immersive environment to stimulate students to conduct deeper learning. The author targeted at serious games and game-based learning in industrial engineering, summarized the pros and cons of taking games as educational tools, and proposed ways for game developers to consider how to make game aspects in line with the learning results in the cognitive and affective domains. Abdullah et al. [24] designed a questionnaire containing items of the readiness of teachers in implementing STEM (an acronym for Science, Technology, Engineering and Mathematics) from the cognitive, affective, and behavioral aspects and used it to determine Malaysian teachers' willingness to implement STEM education from the said aspects. The authors gave a descriptive statistical analysis with the help of SPSS software, and their research results suggest that teachers' readiness in all three aspects studied are at a moderate level, compared with the aspects of behavior and emotion, they are better ready in the aspect of cognition. Alias et al. [25] proposed a framework for merging the affective dimension of learning into engineering education so that it could promote learning in the cognitive domain. The authors analyzed four major learning theories of behaviorism, cognitivism, socio-culturalism, and constructivism, and determined a few assumptions concerning the influence on the cognition. In the paper, self-efficacy, attitude, and locus of control have been regarded as affective domain constructs; then, based on the analysis results, they proposed a framework that combines learning methodologies in the cognitive domain with the affective dimension of learning.

After reviewing relevant literatures, it's found that the research on the coordinated development of young teachers' vocational happiness and their AEA is quite insufficient, only 1–2 articles have discussed it from the perspective of a single ability, there isn't complete research on the AEA system of teachers. In view of this, this paper aims to study the CCD of the development of young teachers' vocational happiness and their AEA, hoping to provide theoretical evidence for similar studies. The theory of

emotional intelligence and positive psychology are the theoretical basis of this paper. In the second chapter, this paper builds a framework for young teachers' affective education and an AEA training model, and employs ANN to extract the time series data features of the six evaluation indexes of young teachers' AEA. In the third chapter, this paper uses the CCD to measure the coupling and coordination of the development level of young teachers' vocational happiness and their AEA, and gives the quantification process. In the fourth chapter, this paper adopts the GRA to quantify the influence degree of all indexes on young teachers' vocational happiness and their AEA, thereby realizing the quantitative measurement of each evaluation index on the comprehensive development of the two. At last, experimental results are drawn to verify the measurement and analysis results of the coupling and coordination of the two.

2 Decomposition and evaluation of young teachers' AEA

According to existing literatures, until now there isn't research on the evaluation of teachers' AEA at the micro level, and the macro level studies have generally ignored teachers' control over emotions, which is not good for teachers to better carry out related teaching activities. This paper holds that the development of young teachers' vocational happiness and the development of their AEA are mutually reinforcing, so the evaluation of young teachers' AEA changes dynamically with the change of their vocational happiness.

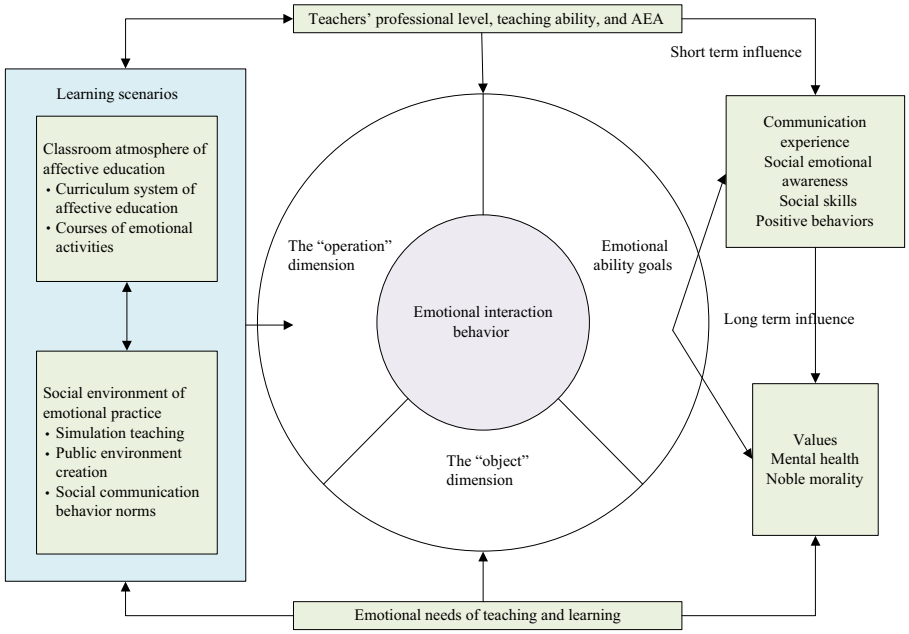

Fig. 1. Framework diagram of the affective education of young teachers

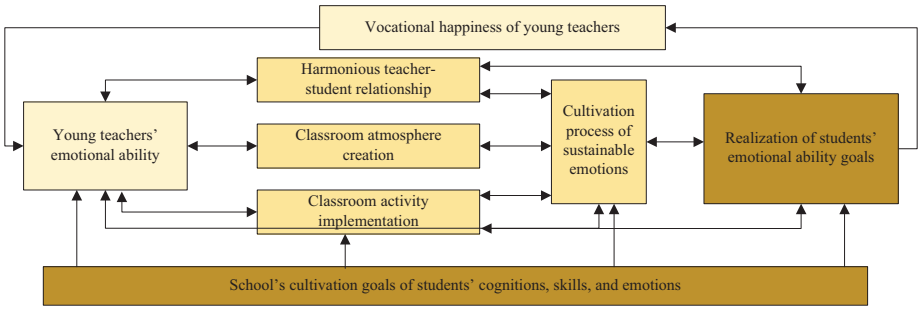

Fig. 2. The AEA training model

Based on previous studies, this paper constructed a framework of the affective education of young teachers, as shown in Figure 1, according to the three-dimensional structure of intelligence, this paper divided the AEA into two dimensions of "operation" and "object". The "operation" dimension includes young teachers' emotion cognition, emotion expression, and emotion adjustment, which are realized in the classroom atmosphere of affective education and the social environment of emotional practice, and they could describe the activities of young teachers' AEA. The "object" dimension includes the young teachers' own emotions generated when they are giving affective education to students, the emotions generated by students, and the teaching material emotions adopted, which correspond to the emotional needs of teachers and students during the teaching and learning process, and they could describe the related content objects of young teachers' AEA. The combination of the two dimensions "operation" and "object" divides AEA into six dimensions. The training goals of students' emotional ability include short-term goals and long-term goals. The short-term goals include the communication experience, social emotional awareness, social skills, and positive behaviors. The long-term goals include the values, mental health, and noble morality.

Figure 2 gives the AEA training model. With the framework of the affective education of young teachers as the basic structure, this model is used to describe the relationships between the coordinated development of young teachers' vocational happiness and AEA and the various variables such as teacher-student relationship, classroom atmosphere creation, classroom activity implementation, cultivation process of sustainable emotions, the realization of students' emotional ability goals, and the school's cultivation goals of students' cognitions, skills, and emotions.

During the coupled and coordinated development of young teachers' vocational happiness and AEA, in order to attain the features of the dynamic changes of AEA, this paper employed the ANN to extract the time series data features of the divided six evaluation index of young teachers' AEA. Combining the merits of the conventional BPNN (Back Propagation Neural Network) and LSTM (Long Short Term Memory) neural network, this paper built a combined model of the two.

Assuming: the evaluation values of BPNN and LSTM neural network after subjected to inverse normalization are denoted as o_1 and o_2; to calculate the weight of the combined model, set the weight values of the BPNN and LSTM neural network as θ_1

and θ_2, the sums of the error squares of BPNN and LSTM neural network are denoted as C_1 and C_2, o_i represents the i-th real value; o_i' represents the i-th predicted value, then the weight of the combined mode can be calculated using the following formula:

$$\theta_1 = \frac{C_1^{-1}}{C_1^{-1} + C_2^{-1}}, \theta_2 = \frac{C_2^{-1}}{C_1^{-1} + C_2^{-1}} \tag{1}$$

$$C = \sum_{e=1}^{E} (o_i - o_i')^2 \tag{2}$$

The formula below gives the final evaluation result of the combined model:

$$O = Q_1 \times o_1 + Q_2 \times o_2 \tag{3}$$

3 Construction of CCD evaluation model

CCD calculation is a quantitative analysis method that describes the coupling and coordination between the development level of young teachers' vocational happiness and the development level of their six kinds of AEA. Referring the existing CCD evaluation models, this paper calculated the CCD and the specific calculation steps are:

STEP 1: build two sets of evaluation indexes A_i and B_i to represent the young teachers' vocational happiness and their six kinds of AEA, wherein n represents the number of evaluation indexes of vocational happiness, and m represents the number of evaluation indexes of the six kinds of AEA.

STEP 2: Standardize A_i and B_i and calculate the weight values of the evaluation indexes, the formulas below show the standardization processing of the positive and negative effects of A_i:

$$A_{ij} = (A_i - A_{min}) / (A_{max} - A_{min}) \tag{4}$$

$$A_{ij} = (A_{max} - A_i) / (A_{max} - A_{min}) \tag{5}$$

Assuming: A_{ij} are the results of the standardization processing of A_i; A_{max} and A_{min} are the maximum and minimum values of the standardization results. Similarly, we can get B_{ij}, namely the results of the standardization processing of B_i.

Use the entropy weight method for weight calculation: normalize A_{ij} and B_{ij}, see below:

$$GX_{ij}^{A} = A_{ij} \div \sum_{i=1}^{m} A_{ij}, GX_{ij}^{B} = B_{ij} \div \sum_{i=1}^{m} B_{ij} \tag{6}$$

In this paper, the research on the coupling coordination between the vocational happiness and six kinds of AEA of young teachers is conducted with each semester as a unit, so the entropy GX_i is the total amount of contributions of all semesters to A_i:

$$GX_i = -ln(m)^{-1} \sum_{i=1}^{m} e_{ij} \, lne_{ij} \tag{7}$$

The formula for calculating redundancy degree is:

$$RED_i = 1 - GX_i \tag{8}$$

The weight of corresponding evaluation indexes could be calculated by the following formula:

$$\theta_i = RED_i \div \sum_{i}^{m} RED_i \tag{9}$$

Similarly, the weight λ_i corresponding to indexes in B_i can be attained:

STEP 3: establish evaluation functions of young teachers' vocational happiness and six kinds of AEA as follows:

$$\Omega(a) = \sum_{i=1}^{n} \theta_i A_{ij} \tag{10}$$

$$\Psi(b) = \sum_{i}^{m} \lambda_i B_{ij} \tag{11}$$

STEP 4: assuming l represents the coefficient of adjustment, here it describes the number of young teachers' AEA, that is, l=9. Next, build the *COC* (coefficient of coupling) function that measures the coupling degree of the development level of young teachers' vocational happiness and their six kinds of AEA:

$$COC = \Omega(A) \times \Psi(B) / [(\Omega(A) + \Psi(B)) / 2]^l \tag{12}$$

The value range of *COC* is [0, 1]. The smaller the value of *COC*, the lower the coupling degree between young teachers' vocational happiness and their six kinds of AEA, and the greater the value of *COC*, the higher the coupling degree.

STEP 5: Calculate *CCD* based on the following formula:

$$C = \sqrt{D \cdot O} \tag{13}$$

The value range of *CCD* is [0, 1]. When *CCD* is 1, it indicates that the coordination state of young teachers' vocational happiness and their six kinds of AEA is the optimal; the greater the value of *CCD*, the more coordinated the development of the two; the smaller the value of *CCS*, the less coordinated the development of the two.

Assuming: *CHI* represents the comprehensive harmonization index of young teachers' vocational happiness and their six kinds of AEA; η and κ represent the weights corresponding to young teachers' vocational happiness and their six kinds of AEA, then there is:

$$CHI = \eta \cdot \Omega(A) A + \kappa \cdot \psi(B) \tag{14}$$

4 Modeling of the influencing factors of CCD

Based on the extracted evaluation index system of young teachers' vocational happiness and their six kinds of AEA, this paper holds that all the extracted evaluation indexes have certain influence on the CCD of the development of the two, and the GRA has been adopted to quantify the influence degree of all indexes on the CCD so as to measure the influence of each evaluation index on the comprehensive development of young teachers' vocational happiness and their six kinds of AEA. To make our suggestions proposed for the comprehensive development of the two more targeted, this paper referred to existing relevant studies and constructed a model for the influencing factors of CCD, the specific modelling steps are:

STEP 1: with the CCD of young teachers' vocational happiness and their six kinds of AEA in different semesters as the reference sequence, a set $A_0 = \{A_0(1), A_0(2), \ldots, A_0(M)\}$ is built; then with the evaluation indexes of the two as the comparative sequence, another set $A_i = \{A_i(1), A_i(2), \ldots, A_i(M)\}$ is built, wherein $i = 1, 2, \ldots, N$, N is the total number of indexes, M represents the semester; since this paper has selected the evaluation index data of 12 semesters from 2015 to 2020, M=12.

STEP 2: Calculate the maximum and minimum difference between A_0 and A_i, the calculation formula is:

$$\Delta_i(o) = \left|A_0(o) - A_i(o)\right|, i = 1, 2, 3, ..., 21 \tag{15}$$

The specific process is: at first, calculate the absolute difference between A_0 and A_i, and get the comparative sequences corresponding to the maximum value and the minimum value of the absolute difference, then, find the maximum value and the minimum value in the two comparative sequences, which are respectively represented by Δ_{max} and Δ_{min}.

STEP 3: Assuming: χ represents the identification coefficient, the grey relational coefficient can be calculated by the following formula:

$$\tau_i(l) = \frac{\Delta_{min} + \chi\Delta_{max}}{\Delta_i(o) + \chi\Delta_{max}} \tag{16}$$

STEP 4: Because only the evaluation index data in a same time series can be subjected to the calculation of grey relational degree, so in order to measure the grey relational degree of the comprehensive development of young teachers' vocational happiness and their six kinds of AEA, this paper calculated the average values of the evaluation index data of 12 semesters in different time series and used them to construct the evaluation index data in the same time series. The calculation formula of grey relational degree ϕ_i is:

$$\phi_i(l) = \frac{1}{m}\sum_{l=1}^{m}\Phi_i(l) \tag{17}$$

STEP 5: Based on above steps, the grey relational degree ϕ_i of each evaluation index of young teachers' vocational happiness and their six kinds of AEA can be calculated. The greater the value of ϕ_i, the greater the influence of the evaluation index on the CCD of young teachers' vocational happiness and their six kinds of AEA, based on the above principle, all evaluation indexes could be sorted.

5 Experimental results and analysis

In this paper, the teachers' vocational happiness was evaluated from 11 aspects which were then ranked from high to low according to the size of the evaluation results, they are: the sense of achievement at work, the academic progress of students, students' respect, improvement of teaching ability, pursuit of educational career, realization of self-value, diligence and efforts of students, the joint advancement of teaching and learning, the recognition of colleagues and schools, and the sense of nobleness of the profession. From the Figure 3, it's known that, at present, the teachers' vocational happiness is not high, and the feedback from students has determined the spiritual satisfaction of teachers. Another important fact is that the teachers' pursuit of educational career, the improvement of their teaching ability and professional quality, and the internal attributes of teachers themselves are the decisive factors. Then, the above 11 aspects were merged into 7 dimensions: teacher emotion dimension, student emotion dimension, teacher ability dimension, vocation dimension, work achievement dimension, and social recognition dimension. Table 1 gives the evaluation results of young teachers' vocational happiness.

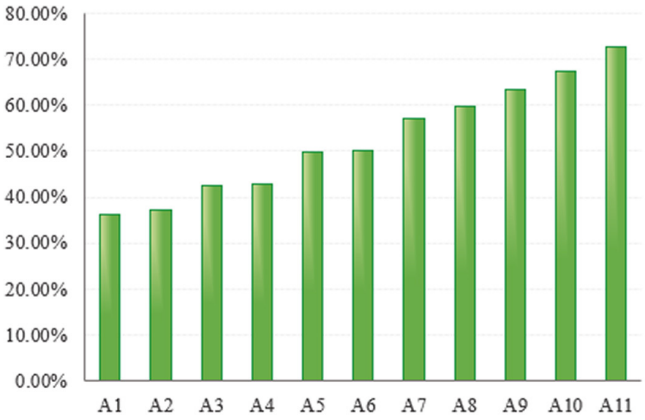

Fig. 3. Evaluation of teachers' vocational happiness

Table 1. Evaluation results of young teachers' vocational happiness

	Mean	Standard Deviation	Minimum	Maximum
Teacher emotion dimension	2.18	0.61	1.39	4.61
Student emotion dimension	2.65	0.69	0.86	4.38
Teacher ability dimension	2.41	0.5	1.47	4.52
Vocation dimension	3.18	0.45	1.25	4.67
Work achievement dimension	3.56	0.42	1.93	4.35
Social recognition dimension	3.48	0.41	1.75	4.08
Total	2.62	0.35	1.27	4.58

Table 2. Evaluation results of young teachers' AEA

	Mean	Standard Deviation	Minimum	Maximum
"Operation" dimension-1	3.14	0.42	1.62	4.17
"Operation" dimension-2	3.62	0.47	2.47	4.52
"Operation" dimension-3	3.74	0.45	2.31	4.39
"Object" dimension-1	3.59	0.41	1.29	4.57
"Object" dimension-2	3.61	0.49	1.65	4.95
"Object" dimension-3	3.52	0.43	1.07	4.61
Total	3.68	0.46	1.39	4.27

Table 3. Correlation analysis of various dimensions of vocational happiness and AEA of young college teachers

	Teacher Emotions	Student Emotions	Teacher Ability	Teacher Career	Work Achievement	Social Recognition
"Operation" dimension-1	0.148**	0.259**	0.319**	0.462**	0.429**	0.469**
"Operation" dimension-2	0.295**	0.206**	0.331**	0.538**	0.515**	0.537**
"Operation" dimension-3	0.217**	0.237**	0.324**	0.416**	0.438**	0.519**
"Object" dimension-1	0.136**	0.213**	0.359**	0.528**	0.526**	0.631**
"Object" dimension-2	0.158**	0.296**	0.316**	0.536**	0.591**	0.584**
"Object" dimension-3	0.246**	0.318**	0.424**	0.619**	0.647**	0.697**

Table 2 gives the evaluation results of young teachers' AEA. According to the table, the six dimensions of young teachers' AEA from high to low are: the teachers' ability to adjust their own emotions when giving affective education to students, the emotion expression ability, the emotions generated by students, the emotions generated by teachers, the teaching material emotions adopted, and the teachers' emotion cognition ability. Overall speaking, the AEA is at a medium-high level.

Table 3 gives the correlation analysis of the various dimensions of young college teachers' vocational happiness and their AEA. The six dimensions of vocational happiness and the six dimensions of AEA show significant positive correlation ($p < 0.01$). Between the "operation" dimension and the "object" dimension of young teachers' AEA, there're significant differences in the vocational happiness. Table 4 gives the results of the difference test on young teachers with different levels of AEA in terms vocational happiness and each dimension. According to the table, the "operation" dimension is significantly higher than the "object" dimension. For five dimensions out of the six dimensions of AEA, the scores of the "operation" dimension are significantly higher than those of the "object" dimension.

By evaluating the vocational happiness and AEA of 37 young teacher samples in the target college, the distribution features of the CCD of the vocational happiness and AEA of young teachers in the region could be attained. With two semesters in 2020 as nodes to perform analysis, Figure 4 shows the distribution features of CCD in terms of six dimensions of AEA. According to the figure, in the two semesters in 2020, for most dimensions, the CCD of the development level of young teachers' AEA and vocational happiness is relatively high, reaching more than 20%. The distribution features of each evaluation index in "operation" and "object" dimensions are consistent, while the CCD of the "object" dimension is significantly lower than that of the "operation" dimension, mainly distributed between 10% and 20%, indicating that when teachers are giving affective education to students, their own emotion cognition, emotion expression, and emotion adjustment are more important to their spiritual and professional happiness.

Table 5 gives the analysis results of the main influencing factors of CCD. According to the table, in 2015, there're 9 evaluation index influencing factors with a CCD over 10% and in the top five, while in 2020, this number is 10, showing an increase, which indicates that the CCD of the evaluation indexes is more concentrated, and this result is close to the previous analysis result of the change trend of CCD. Besides, it could be found that the top six high-frequency evaluation index influencing factors of 2015 are the same with those of 2020, the factors that can affect the coordinated development of vocational happiness and AEA are mainly indexes with high correlation, which is reflected in both the "operation" dimension and the "object" dimension, and the frequency is mainly distributed within the 75%–100% interval.

Table 4. Results of difference test on young teachers with different levels of AEA in terms vocational happiness and each dimension

	"Operation" Dimension	**"Object" Dimension**	***T***	***SIG***
Overall vocational happiness	3.25 ± 0.31	2.16 ± 0.38	7.49	0.02
Teacher emotion dimension	2.59 ± 0.74	2.08 ± 0.65	5.34	0.03
Student emotion dimension	2.12 ± 0.72	2.41 ± 0.52	5.26	0.29
Teacher ability dimension	3.15 ± 0.58	2.13 ± 0.42	7.61	0.04
Vocation dimension	3.69 ± 0.45	2.09 ± 0.38	1.25	0.26
Work achievement dimension	3.28 ± 0.49	2.75 ± 0.34	6.27	0.09
Social recognition dimension	2.49 ± 0.57	2.36 ± 0.49	4.92	0.06

Table 5. Analysis of main influencing factors of CCD

	2015			**2020**		
Rank	**Factor**	**Number of Appearances**	**Frequency (%)**	**Factor**	**Number of Appearances**	**Frequency (%)**
1	B_3	36	96.25	A_8	39	94.15
2	B_6	36	96.11	B_2	38	85.37
3	B_2	36	96.05	A_5	28	75.19
4	A_5	36	90.41	A_9	23	72.35
5	A_1	35	85.62	A_1	15	56.29
6	A_8	33	85.14	B_6	13	33.14
7	B_1	9	20.36	B_4	10	25.19
8	B_4	5	15.49	B_3	8	20.57
9	A_6	3	12.52	B_1	6	7.48
10				B_5	3	7.35

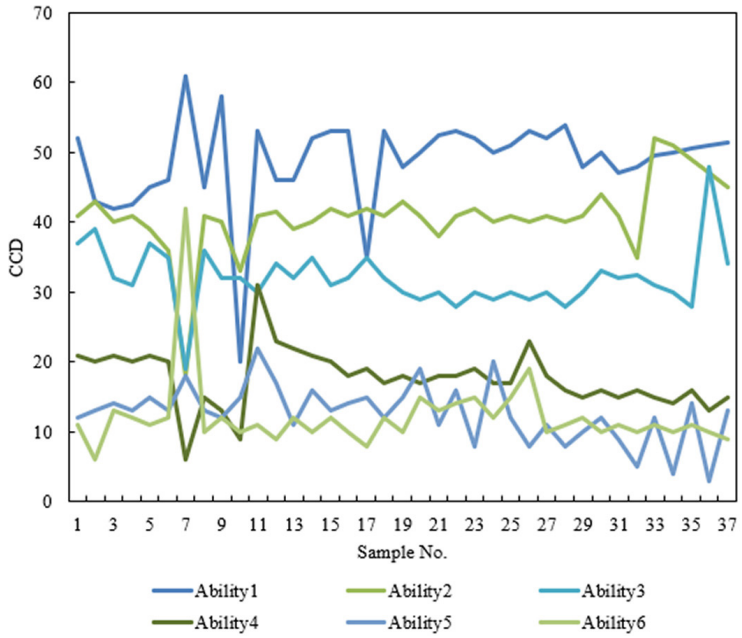

Fig. 4. Distribution features of CCD in terms of six dimensions of AEA

6 Conclusion

This paper measured the coupling coordination of the development of young teachers' vocational happiness and their AEA based on the theory of emotional intelligence and positive psychology. In the second chapter, this paper built a framework for young teachers' affective education and an AEA training model, and employed ANN to extract the time series data features of the divided six evaluation indexes of young teachers' AEA. In the third chapter, this paper used the CCD to measure the coupling and coordination of development level of young teachers' vocational happiness and their AEA, and gave the quantification process. In the fourth chapter, this paper adopted the GRA to quantify the influence degree of all indexes on young teachers' vocational happiness and their six kinds of AEA, thereby realizing the quantitative measurement of each evaluation index on the comprehensive development of the two. Combining with experiment, this paper gave the evaluations results of young teachers' vocational happiness and AEA, conducted correlation analysis on each dimension of young teachers' vocational happiness and AEA, and tested the differences in vocational happiness and each dimension of young college teachers with different levels of AEA.

The distribution features of CCD in terms of the six dimensions of AEA were attained, which verified that when teachers are giving affective education to students, their own emotion cognition, emotion expression, and emotion adjustment are more important to their spiritual and professional happiness.

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