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Students' Growth Dynamic Evaluation Modeling Based on Curriculum Learning State

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Abstract: Proposed in this paper, a kind of students' learning state tracking and evaluation model, centered on teaching activities, was based on recording students' behavior state in every activity space, during every teaching procedure. Firstly, a growth evaluation index system has been constructed based on fuzzy AHP. Five items indexes and one growth index could be computed out after completing count, weighted sum and normalization. Those five items are virtue, ability, diligence, achievements and participation. Every item has five second index for assessment. This evaluation system is consistent with Chinese modern education goals. A detailed calculation arithmetical model of each index has been given which can interpret precisely the meaning of those indexes. Then, a computer model has been constructed for picking up and measuring information of students. A computer system of students' growth dynamic evaluation has been introduced. At last, a practical example was taken to show that this model is feasible for evaluating students' growth in our classes last 3 years.

Key words: Applications in subject areas; evaluation methodologies; evaluation of CAL systems; improving classroom teaching system

INTRODUCTION

Students' learning quality evaluation was taken in almost every subjects of all high-grade teaching by the end of the items. As formative assessment is highly valued today, usual performance always recognized as valuable references in students' learning quality evaluation. Three common methods were adopted to evaluate students' usual performance: first, the scores were based on the impressions students leave on teachers; second, taking the final examination into consideration, combined with the impressions and teachers' feelings; third, the usual performance scores, existed as a form, totally depend on the final examination. With the higher education's development and expansion in China, it's very common to see a class of ordinary colleges and universities has more than 30 students while a teacher has only one lesson in a class each week, immersing themselves in their PowerPoint presentations with little communication with students. How to have better understanding of the students becomes an urgent problem which needs to be solved. Since teachers have no time to know students' growth well, the first and second methods exist in a form only. Although the elementary and middle schools as basic education allowed teachers to have more time and chance to know and communicate with students, students' growth evaluation didn't get improved as well because of the knowledge-inculcation model. Therefore, the students'

learning assessment essentially once again returns to summative assessment: judge a student all by exams and exams decide a student's life which obviously becomes an obstacle to meet with China's current educational reform's need, to achieve modern educational philosophy and to reach the most basic education goal. A kind of new college students' growth dynamic evaluation modeling based on curriculum learning state is proposed in this paper, aiming to meet schools' need to evaluate students' learning state and growth scientifically and enable schools make comprehensive and process-based evaluations to students.

REVIEW OF RESEARCH ON STUDENTS' LEARNING STATE AND GROWTH EVALUATION

Formative assessment is the root of China's new curriculum reform which aims at having a good understanding of students from their learning state and then obtaining the learning performance evaluation objectively and scientifically. Generally education theories discuss learning state from two aspects: psychological and physical state (Liu, 2003). It not only includes students' learning state in the classroom from microcosmic perspective, but also the performance characteristics at school from macrocosmic perspective. In practice, it's impossible for a teacher to gain an insight into students' learning state, especially recognize the change of the state, so as to take appropriate action in the

limited 45 min. Education theory generally believed psychological state should be relatively stable, so the "mood, motivation and attention" (Zhang and Liu, 2011) is more inclined to be considered as psychological quality. The starting point of the new curriculum reform in China tends to use this kind of stability, combined with teachers' guidance, to help students form a good learning state (Chen and He, 2007). But students' learning state changed gradually, affected by both the environment and teachers themselves. So it is vital for teachers to know the students and their change well and create a good environment to improve students' learning state. However, in practical teaching, the process of change is hard to be recognized and teachers often overlook the small changes or have no idea about it so that they find this process ultimately like an abrupt change, because it really needs wisdom to recognize the possible qualitative change from the slow quantitative change. But no matter what, judging a student only by his or her final examination score or diplomas is obviously inconsistent with the education reform.

Do some short, simple notes in paper form to record students' change which was used to be adopted, but it seems to be a daunting task that was waste of time and space and was trivial to manage. In domestic middle and primary school, the so called "growth record bag" or "portfolios" has been used for many years (Liu, 2004). And it was once introduced to the university called "growth record sheet". In theory, it contains students' achievements, works, teachers' evaluation and some others involved in the process (Guo, 2011). The original idea is to write some realistic evaluation, such as verbal description. While the realistic evaluation was always replaced by a summative assessment of one term due to a lack of the accumulation of normal class performance records which has ignored that what changes a student decisively is the process of each class and the supplementary activities after class. Therefore, "growth record sheet" actually can only describe the macroscopic learning status, but cannot reflect the microscopic learning status during the class. It should be said that this kind of means is of little use because of the restriction of many objective conditions. In recent years, computer and network information system has been used in the classroom teaching, hoping through innovative teaching mode to improve the students' learning state and through understanding the student's learning state to improve the way that "how to teach" and "how to learn". However, the fact proves that this kind of innovation didn't return for the students' effective learning state, at least not positively correlated(Li and Li, 2010). Besides, information system was also proposed to realize the process of

tracking and evaluation of the students' network course (distance education mode). Thus researchers can use computational intelligence to analyze the learning state and discover the internal cause of students' growth(Liu and Zhou, 2007). In the West, this record bag actually is the so-called "e-Portfolios". A running application system is rarely to see in China while the west already has a relatively complete system and has been used widely, for example, using the electronic portfolios to strengthen students' self-adjustment ability of learning, realize lifelong education and track practice quality (Cambridge, 2008; Attwell, 2007; Alexiou and Paraskeva, 2010; Garrett and Jackson, 2006).

There are obvious differences in form between Chinese education and western education, so does the essential differences and both of them are reflected in the classroom. Western education focuses on cultivating students' ability of learning, while the Chinese education emphasizes the acquisition of knowledge. Even if Chinese education is in progress of reform for years when the conception of modern education is becoming more popular day by day, but it's just started to give up infusion and emphasize the development of individual. Thus it's impossible for China to copy the Western's mode to solve Chinese education's problem. Students' learning assessment is a basic problem in teaching. If the learning process is regarded as a process of growth, the growth evaluation is the first problem we are facing. But the development is related to every course's teaching. As for the learning state involved in classroom teaching, how to make it be recalled inducted and calculated through computer system has not been discussed yet in West or China. Even the electronic portfolio is just a realistic description in stages, at the same time, it's not convenient to observe and study students or let them introspect whenever and wherever. Therefore, as to Chinese course teaching, it still needs further research to solve the tracking problem of the changes of students' learning state through information technology, aiming at evaluating students objectively and scientifically and achieving the aim of education.

THE GROWTH EVALUATION MODEL BASED ON THE STATE TRACKING

Based on the Students' learning state tracking, the growth evaluation model, with a core of the basic course teaching management in classroom, extends to the learning activities before class and after class to track information recording of the students learning state. The method is that: By the means of the student status tracking and based on the formative assessment, it is to

realize the dynamic growth evaluation and then get the summative assessment eventually. The model includes 2 parts: the one is the theoretical model; the other is the computing system model.

The index system based on AHP: Based on state tracking, growth evaluation model, aiming to realize national "education aim" as a basic goal and reflect "ethics, ability, diligence, achievements and teamwork" and other aspects of development characteristics, consists of a comprehensive index and five sub-indexes. Students' growth evaluation system based on AHP (Analytic Hierarchy Process) is shown in Fig. 1.

From Fig. 1, it is known that for a course, from the beginning of class to the end, a college student's all activities performances both inside and outside the classroom, including quantity, quality, time and other characteristics, are observed and recorded and become one item of the indexes. Five primary indexes in all, each one has several secondary indexes. The 5 primary indexes can be combined into a development index-Growth Index. The meaning and evaluation method of each index is stated below:

- Morality Index aims at prompting students forming a good learning attitude and a sense of obedience to laws and regulations, mainly to study the behavioral characteristics of the students in the class, such as the slapstick in class, late for completing the paper home-works or network home-works, late for class or leave early which have a negative impact on the formation of good qualities
- Ability mainly refers to innovation capability. It aims at investigating the formation and development of innovation capacity, mainly from three aspects: (1) Evaluation made by the teacher on students' innovation in the reciprocal teaching mode; (2) Evaluation on the display of innovative capacity in students' forums and blogs according to the number of fans; (3) The innovative capacity reflected in the quality of homework
- Performance Index aims at evaluating students' knowledge learning performance both inside and outside the classroom, mainly from four aspects: (1) The quality of the homework judged by teacher; (2) The quality of the network practice judged by the system; (3) Response degree of the forum discussion, including the opposite and approving perspectives; (4) response degree of the blog posts

- Cooperation Index describes the situation of students' participation in the teaching action inside and outside classroom. It aims at investigating the following aspects: (1) The situation that students participate in the student-teacher interaction in the classroom; (2) The effect of team cooperation in group discussions, including the times of participation; (3) The times of the active participation in Internet theme forum; (4) The number of blog views and evaluation. This Index can't be formed in the traditional teaching methods
- Diligence Index is used to evaluate students' learning characteristics according to students' learning activities inside and outside the classroom, mainly from the following aspects: (1) The number of the related topics blogs; (2) Daily attendance, including absence, tardiness, early leave, sick leave and personal leave and other acts; (3) The absolute number of network exercises completed; (4) The absolute number of homework completed

The calculation method based on Fuzzy AHP: From Fig. 1, it is known that the secondary indexes are used to evaluate some external characteristics of students. The evaluation method of each dimension varies with each other and the reason is that the difference in the unit of each dimensions, as well as the significance of the numerical size. In addition, each low-level indicator has different impact (numerical value is the weights of each sub-layer's index) on their superior item.

In order to make the data of different indexes and different dimension processed with a same unit, those data need to be normalized and the fuzzy mathematical method usually be used to calculate the membership degree. There are three models used to calculate and evaluate the index membership: maximum, minimum and fixed value. This calculation method is simple and effective.

Arithmetic model of each index: As showed in Fig. 1, g_i , g_{ij} , w_i and w_{ij} correspondingly represent each first and second level index. In order to effectively monitor students' learning state, this model has been introduced penalty coefficient λ for calculating abnormal learning state. To every student, initial value, for example, 80, is set to every index. In all functions we assumed $0/0 = 0$.

Good comment Rate of performance in class (g_{11}^*) = $((80 + \text{good comment number of someone/the highest good comment number in class} \times 20) + (80 - \text{bad comment number of someone/the highest bad comment number in class} \times \lambda \times 20)) / 2$.

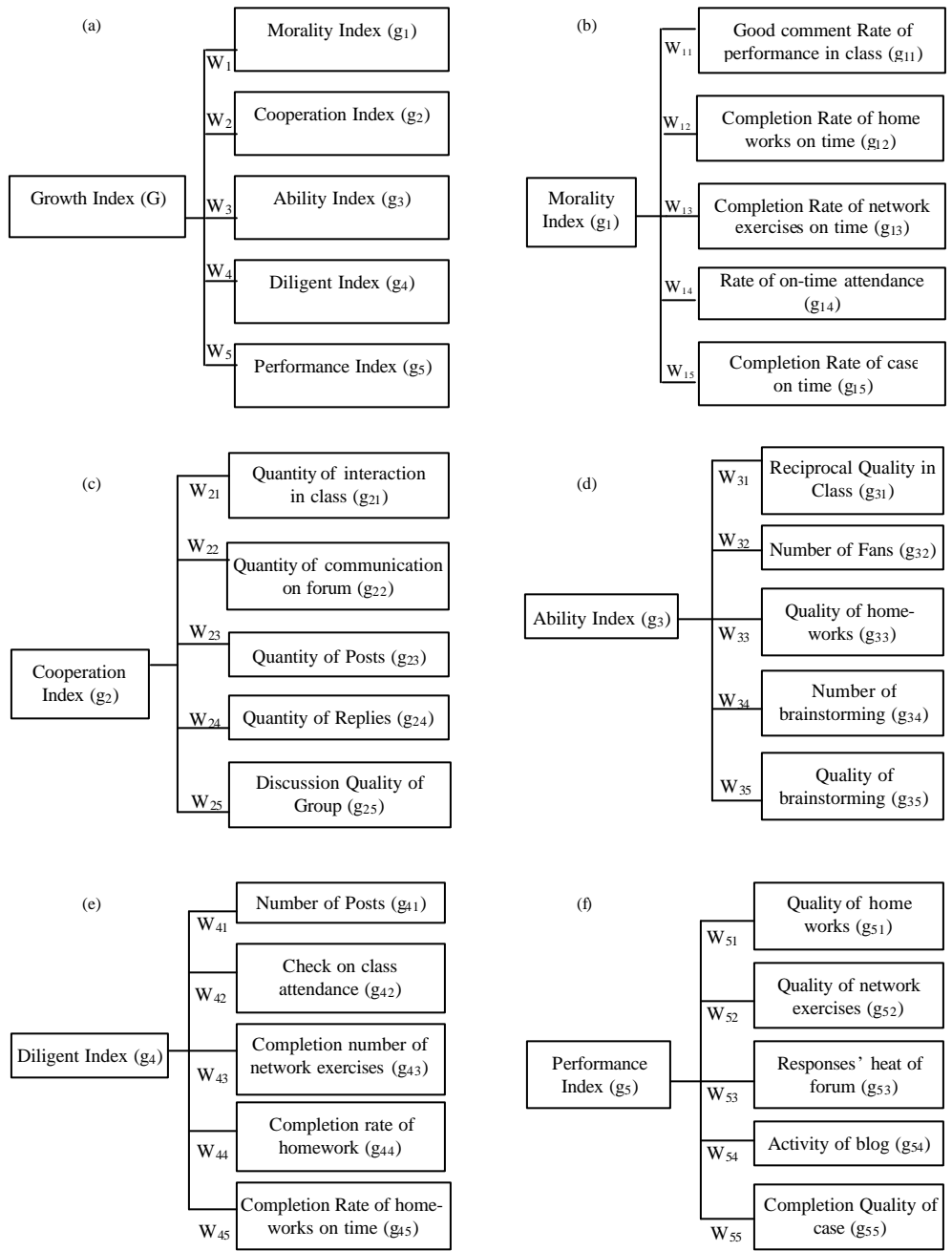


Fig. 1: Growth evaluation indexes system based on state tracking

$$g_{11}' = (g_{11} * - \min (g_{11})) / (\max (g_{11}) - \min (g_{11})) \times 100$$

Completion Rate of home works on time (g₁₂*) = ((80+the number of homework completed on time of someone/total number of homework×20)+(80-the number of homework completed not on time of someone/total number of home works×λ×20))/2.

$$g_{12}' = (g_{12} * - \min (g_{12})) / (\max (g_{12}) - \min (g_{12})) \times 100$$

Completion Rate of network exercises on time (g₁₃*) = ((80+the number of network exercises completed on time of someone/total number of network exercises in class×20)+(80-the number of network exercises completed not on time of

someone/total number of network exercises in class $\times\lambda\times 20$)/2.

$$g_{13}' = (g_{13}^* - \min(g_{13})) / (\max(g_{13}) - \min(g_{13})) \times 100$$

The Rate of on-time attendance (g_{14}^*) = ((80+the number of on-time attendance of someone/the total number of someone's classes $\times 20$)+(80-the number of not on-time attendance of someone/the total number of someone's classes $\times\lambda\times 20$))/2.

$$g_{14}' = (g_{14}^* - \min(g_{14})) / (\max(g_{14}) - \min(g_{14})) \times 100$$

Completion Rate of case on time (g_{15}^*) = ((80+the number of case analysis completed on time of someone/total number of cases in class $\times 20$)+(80-the number of case analysis completed not on time of someone)/total number of cases in the class $\times\lambda\times 20$))/2.

$$g_{15}' = (g_{15}^* - \min(g_{15})) / (\max(g_{15}) - \min(g_{15})) \times 100$$

Morality Index (g_1') = $g_{11}' \times w_{11} + g_{12}' \times w_{12} + g_{13}' \times w_{13} + g_{14}' \times w_{14} + g_{15}' \times w_{15}$

Quantity of interaction in class (g_{21}^*) = ((80+the number of someone praised because of interaction/the maximum number of students praised because of interaction in class $\times 20$)+(80-the number of someone criticized because of interaction)/the maximum number of students criticized because of interaction in class $\times\lambda\times 20$))/2.

$$g_{21}' = (g_{21}^* - \min(g_{21})) / (\max(g_{21}) - \min(g_{21})) \times 100$$

Quantity of communication on forum (g_{22}^*) = ((80+the number of complete discussion of someone/total number of discussion in class $\times 20$)+(80-the number of not complete discussion of someone)/total number of discussion in class $\times\lambda\times 20$))/2.

$$g_{22}' = (g_{22}^* - \min(g_{22})) / (\max(g_{22}) - \min(g_{22})) \times 100$$

Quantity of Posts (g_{23}^*) = total posts number of someone on forum/the most total posts number in class $\times 100$.

$$g_{23}' = (g_{23}^* - \min(g_{23})) / (\max(g_{23}) - \min(g_{23})) \times 100$$

Quantity of Replies (g_{24}^*) = total replies number of someone on forum/the most total replies number in class $\times 100$.

$$g_{24}' = (g_{24}^* - \min(g_{24})) / (\max(g_{24}) - \min(g_{24})) \times 100$$

Discussion Quality of Group (g_{25}^*) = total click number of someone on forum/the most total click number in ones class $\times 100$.

$$g_{25}' = (g_{25}^* - \min(g_{25})) / (\max(g_{25}) - \min(g_{25})) \times 100$$

Cooperation Index (g_2) = $g_{21}' \times w_{21} + g_{22}' \times w_{22} + g_{23}' \times w_{23} + g_{24}' \times w_{24} + g_{25}' \times w_{25}$.

Reciprocal Quality in Class (g_{31}^*) = ((80+the score of someone praised because of interaction/the maximum score of students praised because of interaction in class $\times 20$)+(80-the score of someone criticized because of interaction/the maximum score of students criticized because of interaction in ones class $\times\lambda\times 20$))/2.

$$g_{31}' = (g_{31}^* - \min(g_{31})) / (\max(g_{31}) - \min(g_{31})) \times 100$$

Number of Fans (g_{32}^*) = ((80+number of someone supported on forum/the most number of students supported on forum in class $\times 20$)+(80-number of someone opposed on forum/the most number of students opposed on forum in class $\times\lambda\times 20$))/2.

$$g_{32}' = (g_{32}^* - \min(g_{32})) / (\max(g_{32}) - \min(g_{32})) \times 100$$

Quality of homework (g_{33}^*) = ones' homework score assessed by teacher.

$$g_{33}' = (g_{33}^* - \min(g_{33})) / (\max(g_{33}) - \min(g_{33})) \times 100$$

Number of brainstorming (g_{34}^*) = 80+brainstorm number of someone/the most brainstorm number in class $\times 20$.

$$g_{34}' = (g_{34}^* - \min(g_{34})) / (\max(g_{34}) - \min(g_{34})) \times 100$$

Quality of brainstorming (g_{35}^*) = 80+the total score of someone's brainstorm/the most score of brainstorm in class $\times 20$.

$$g_{35}' = (g_{35}^* - \min(g_{35})) / (\max(g_{35}) - \min(g_{35})) \times 100$$

Ability Index (g_3) = $g_{31}' \times w_{31} + g_{32}' \times w_{32} + g_{33}' \times w_{33} + g_{34}' \times w_{34} + g_{35}' \times w_{35}$.

Number of Posts (g_{41}^*) = g_{23}' .

Check on class attendance (g_{42}^*) = ((80+number of being class of someone/total class number $\times 20$)+(80-number of not being class of someone/total class number $\times\lambda\times 20$))/2.

$$g_{42}' = (g_{42}^* - \min(g_{42})) / (\max(g_{42}) - \min(g_{42})) \times 100$$

Completion number of network exercises (g_{43}^*) = ((80+number of network exercises completed of someone/total number of network exercises $\times 20$)+(80

-number of network exercises not completed of someone/total number of network exercises $\times \lambda \times 20$)/2.

$$g_{43}' = (g_{43}^* - \min(g_{43})) / (\max(g_{43}) - \min(g_{43})) \times 100$$

Completion rate of homework (g_{44}^*) = ((80+number of homework completed of someone/total number of homeworks $\times 20$)+(80 -number of homework not completed of someone/total number of homeworks $\times \lambda \times 20$))/2.

$$g_{44}' = (g_{44}^* - \min(g_{44})) / (\max(g_{44}) - \min(g_{44})) \times 100$$

Completion Rate of homework on time (g_{45}^*) = g_{12}' .

$$\text{Diligent Index } (g_4) = g_{41}' \times w_{41} + g_{42}' \times w_{42} + g_{43}' \times w_{43} + g_{44}' \times w_{44} + g_{45}' \times w_{45}$$

Quality of homework (g_{51}) = ones' homework score assessed by teacher.

$$g_{51}' = (g_{51}^* - \min(g_{51})) / (\max(g_{51}) - \min(g_{51})) \times 100$$

Quality of network exercises (g_{52}) = ones' network exercises score assessed by teacher.

$$g_{52}' = (g_{52}^* - \min(g_{52})) / (\max(g_{52}) - \min(g_{52})) \times 100$$

Responses' heat of forum (g_{53}^*) = g_{24}^* .

$$g_{53}' = (g_{53}^* - \min(g_{53})) / (\max(g_{53}) - \min(g_{53})) \times 100$$

Activity of blog (g_{54}) = total number of someone's blogs/the most number of students' blogs in class $\times 100$.

$$g_{54}' = (g_{54}^* - \min(g_{54})) / (\max(g_{54}) - \min(g_{54})) \times 100$$

Completion Quality of case (g_{55}) = ones' case analysis score assessed by teacher.

$$g_{55}' = (g_{55}^* - \min(g_{55})) / (\max(g_{55}) - \min(g_{55})) \times 100$$

$$\text{Performance Index } (g_5) = g_{51}' \times w_{51} + g_{52}' \times w_{52} + g_{53}' \times w_{53} + g_{54}' \times w_{54} + g_{55}' \times w_{55}$$

$$\text{Growth Index } (G) = g_1 \times w_1 + g_2 \times w_2 + g_3 \times w_3 + g_4 \times w_4 + g_5 \times w_5$$

The model of computer system: Figure 2 is a model of computer system of growth evaluation based on learning state. At first the computer system records students' learning state, the information collected by teacher and computer. These operations are divided into two types: the one is that students' behaviors during the class are recorded by the teacher explicitly, the other is that students' network activities recorded by the computer system implicitly. All records are classified and stored in the database, forming the sub-data set. Explicit records are usually existed as "qualitative", such as: "very creative", "truancy", must be quantified so as to be calculated. In practice, as teachers have different understanding of these records, the results may vary. Therefore, mapping relationships need to be established between the qualitative data and quantified data which constitutes interpreting strategy set to convert the qualitative evaluation into quantified evaluation, as shown in Fig. 3.

The model of the calculation process of the computer is shown in Fig. 4, in which the idea of algorithm is to read and convert the index item stored in database and then make the date weighted, added up and normalized. Firstly, according to the meaning of each index item, choose a specific calculating form. For instance, in order to get the attendance rate, you need to calculate the total number of classes and the attendance and finally work out the ratio. Besides, there are also obvious differences in the way of

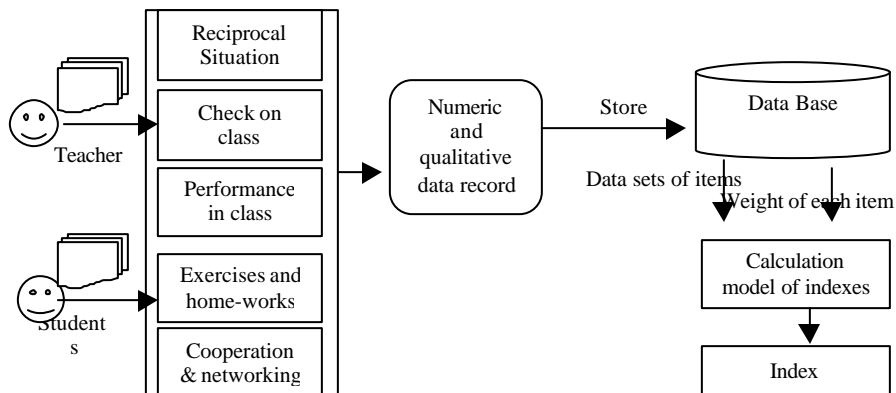


Fig. 2. Computer system model

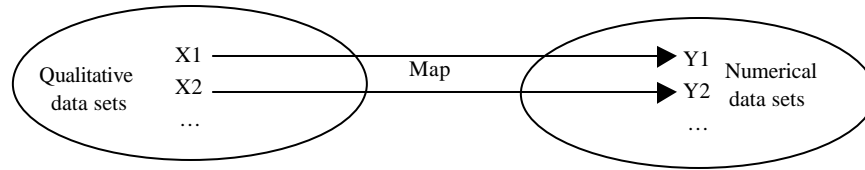


Fig. 3: Map relationship between qualitative data and numerical data

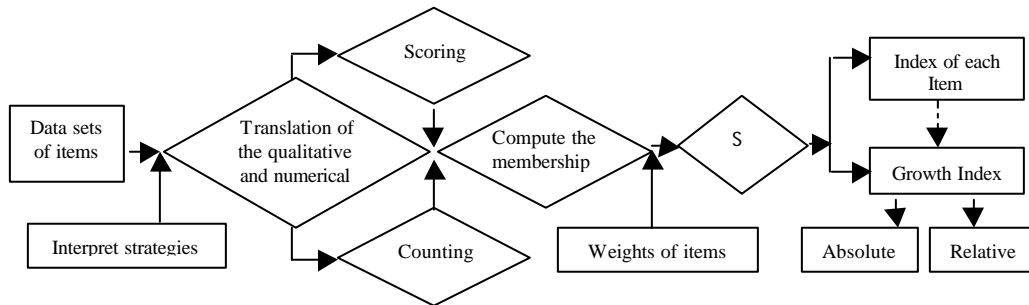


Fig. 4: Computing process of growth evaluation model

calculating the number of "fans" and calculating test scores. Secondly, fuzzy mathematics method is used to calculate the corresponding membership of index item by calculating the best, the worst and the average value of a class. Finally, read the weights of each index item and make them weighted and added up to work out the values of the five first-level indexes and then make them weighted and added up to get the comprehensive growth index.

INSTANCE OF THE EVALUATION MODEL

According to the previous analysis, our research group has successfully developed a tracking system of students' learning state and realized the Students' Growth Dynamic Evaluation on the basis. Due to the limit of space, only two main functional modules of this study will be introduced in this study: the first is teachers' recording window; the second is students' growth index window.

Figure 5 is the screenshots of operation interface used by teachers to record students' learning state during the class. The function of this part is realized in Tablet PC with the Generalized Reciprocal Teaching Intelligent Support System developed by our research group. For example, in the teaching part of brainstorming or other

discussion parts, the system can pick students randomly or assign students. There are three modes to record the characteristics of learning behaviors: "attendance", interactive "praise" and state observation results. The first mode showed may mean the absence of one student and if it is because of sick, it records "sick leave", scored "-1", indicating that lightly inferior than the normal. In order to respond quickly to the class state, the system has provided a collection of common language to facilitate the operation. For example, as for students' answers to a question, the system has provided five commonly used sentences, such as: "very creative" or "keep on working hard" and each sentence correspond to a certain evaluation grade, similar to "good, better, in general, poor and very poor", but more humane and not offensive.

The purpose of students' evaluation is not only to enable teachers to understand students well, but also to push students to study hard to have good development. When faced with students, the system will reconvert the quantitative evaluation into qualitative evaluation. Figure 6 shows the login page checked by students, in which the assessments of five sub-items value of "morality, ability, diligence and performance and cooperation" were expressed by 10 solid five-pointed stars. With 10 solid stars, it represents the best value, while with empty stars, it shows the gap.



Fig. 5: Operation interface of recording students' status with tablet computer



Fig. 6: Feedback information after student's login on system

CONCLUSION

When evaluating students' learning state of a course, the problem we faced is not just how to evaluate students' usual performance, but grasp their learning state of the whole process; And it's not just a problem that how to understand the students, but also to help the students to recognize their leaning state and help the teachers re-adjust their teaching methods. According to the current educational aim in China, a kind of students' growth dynamic evaluation model based on curriculum learning state has been built, reflecting the learning characteristics of students dynamically and meanwhile a computing system has been designed on the basis of the

model, proving that this model is feasible. Although some evaluation indexes have already reflected in some distance education system, yet as the part of the evaluation system of growth proposed and discussed, it provides a useful theoretical model in the formative assessment of students learning. A practical computer network system can make up for the deficiencies of the "growth Recording Bags" mode and provide a new method for the students' evaluation in the high-grade teaching, especially the university teaching. Facts have proved that this model can effectively solve the problems encountered by teachers in evaluating students and help students to recognize their own defects and help teachers to adjust their teaching model quickly. If the curriculum

evaluation of each student on a stage can be connected to the network, a student's comprehensive evaluation can be achieved which is desperately needed by all educators and thus becomes our next research focus.

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