ATLANTIS PRESS

Advances in Social Science, Education and Humanities Research, volume 298

2nd International Conference on Education Science and Social Development (ESSD 2019)

A Study on Talent Training Model of Medical Information Engineering

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***Abstract*—with the wide application of medical information technology, the demand of medical information talents in major enterprises and institutions increases year by year. Whereas the total amount of medical information engineering talents is not in line with the needs of the market, showing a shortage of phenomenon. Hence, some measures need to be taken to make talents better contribute to society. In this context, we proposed the related training model based on Skinner theory, which are divided into two categories—applied talent model and academic talent model, and time manage model. First, we have made some questionnaires to figure out the real demand of students. Then we design these models. Finally, we give the corresponding evaluation factors and the number of evaluations to test whether these models are valid.**

Keywords—medical information engineering, talent training model, skinner theory, time management, evaluation

I. INTRODUCTION

The construction of medical information engineering is mainly based on information science and life science, and it is an interdisciplinary subject that integrates medicine and informatics [1]. In 2003, Sichuan University applied for the first medical information engineering project in China. By 2019, there are nearly 27 universities offering medical information engineering [2], including three in Hubei province: Hubei University of Science and Technology, South-Central University for Nationalities and Hubei University of Chinese Medicine. And medical information engineering as an emerging profession, related universities are in the initial stage of development. Most schools only offer undergraduate education, and only some schools, such as Fudan University, Peking university, Nanjing University and China Medical University, have set up postgraduate majors or research directions in medical information [2]. China's medical information engineering major is oriented to the medical and health field, and hopes to cultivate talents who solve the problems of medical information management and software technology development, maintenance and operation in the field of medicine and health[1]. In developed countries, with the beginning of process automation, the development of medical informatics can be traced back to the second half of 20th century [3]. Most foreign medical informatics are located in departments such as School of Medicine, School of Dental Medicine (Stomatology), School of Pharmacy. It is worth noting that there is a difference in the title of the subject. The most commonly used title of the subject is medical informatics [4]. For some instances, Stanford University combine medical informatics and biomedical information as one subject. Informatics education begins in elementary school so that students at the moment they start their study at the university have already some basic knowledge. And the purpose of the undergraduate study is to enable students to have a more comprehensive medical expertise, familiar with the medical field and understand the information needs in this field. The training level of foreign schools is mainly based on postgraduate and doctoral students [5]. And the aim of medical informatics education is to educate doctors and other health care professionals to manage information more effectively through more accessible, validated clinical indexes, data bases of diagnostic test characteristics, computerized audits of clinical activities with feedback and on-line access to the medical literature etc. [6].

In this paper we established the new models to treat students based on Skinner theory. A quick browsing of this theory, it holds that autonomous learning is essentially an operational behavior, which is based on external reinforcement or self-reinforcement and a reactive response. The formation of autonomous learning ability is essentially that the individual's learning self-regulatory response establishes a connection with the adjacent strength. The role of external reinforcement or self-reinforcement is to guide further responses. Therefore, students can be motivated and promoted by setting up a program of "stimulating-behavior-result-strengthening". Psychologists who hold this view further study the students 'autonomous learning process. It is believed that it mainly contains four sub-processes: self-monitoring, self-guidance, self-evaluation, and self-reinforcement [7]. In essence, by reforming the teaching model, students in medical informatics can better adapt to the development of society and have more choices for the future. In this paper, we have carried out a new expansion, allowing students to more independently choose the direction of future employment and divide students into applied talents and academic talents, in the establishment of relevant models. We have put forward a time management model, which can help students to better allocate time.

The paper is organized as follows. In section 2, we have made some questionnaires, the statistical population of the

research contained two grades (Grade 2015 and Grade 2016) of Hubei University of Chinese Medicine, among whom 100 individuals were chosen as sample size.In addition, the lack of courses in the teaching process is also described.; in section 3, based on Skinner theory, we designed the corresponding talent training models. And we also propose several measures to solve the problems from section 2; in section 4, a time management model is put forward to illustrate students' time allocation in daily life. We design the evaluation mechanism in section 5 to identify the students perform after implementing these models. Finally, in section 6, we outline conclusions and future work.

II. MEDICAL INFORMATION STATUS

In this section, at first, we conduct some surveys to demonstrate the requirements, which are come from the external enterprises (medical software companies and hospitals) and internal students. The former adopts the literature research method, and the latter adopts the questionnaires. Then we find out the existing problems of our school.

A. Literature Research

1) Hospital investigation: Ke Zeng et al. surveyed 50 different hospitals in 15 provinces in China, including 37 top three hospitals and 13 other grade hospitals. The 43 hospitals involved in the survey all have a special information department and the corresponding authority leaders, 93% of the hospitals set up a special information implementation teams, and their main business is network operation and maintenance, information system construction and maintenance, and information equipment management and maintenance. At the same time, the 43 hospitals believe that the knowledge required for medical information talents are: system software or network security technology (88.4%), Computer Programming or Hardware Knowledge (86.0%), Information Retrieval or Data Mining Technology (62.8%), Hospital Operations Management (58.1%) and Medical Knowledge (34.9%) [8].

2) Corporate survey: in China, we learned from Yan Xie [9] who collected the recruitment information of 60 well-known medical software companies. Through the statistical analysis of the recruitment information, it is found that among the 380 recruitment positions of 60 medical software companies, the corresponding personnel require medical background knowledge. There were 141 job postings, accounting for 37.11% of the total number of jobs. There were 165 jobs with different levels of English requirements, accounting for 43.42% of the total number of posts. The importance of the requirements for professional knowledge, ability and basic quality was sorted from high to low: Database Maintenance—System Development—Logical Analysis—Document Writing—New Technology Learning—Network Topology Maintenance—Organization Management—Hardware Maintenance.In developed countries, medical informatics can draw on the lengthy educational outreach experience of other Science, Technology, Engineering, Mathematics, and Computing fields [10]. There are various career choices, the job categories include chief information officer, chief medical informatics officer, chief information security officer, systems analyst, IT department leader, IT and health letter [11]. Kerryn Butler-Henderson et all investigated 420 residents who worked in the field about medical informatics in Australia. They found out that majority organizations ,in which these residents worked, are hospitals (41.5%), and the professional level wages before tax are either between $1500 and $1999 (24.7%), or between $1000 and $1449 (19.1%), or between $2000-$2499 (18.1%). Moreover, the top five areas which required by the corresponding staff reported as "Data", "Technology", "Data analysis", "Data Presentation" and "System". [12]

B. Curriculum Structure

We reviewed the courses of universities offering medical information related majors through the Internet (e.g. Huazhong University of Science and Technology, Central South University, Hubei University of Chinese Medicine and Hunan University of Traditional Chinese Medicine etc.). The core curriculum can be roughly divided into four sections, as shown below.

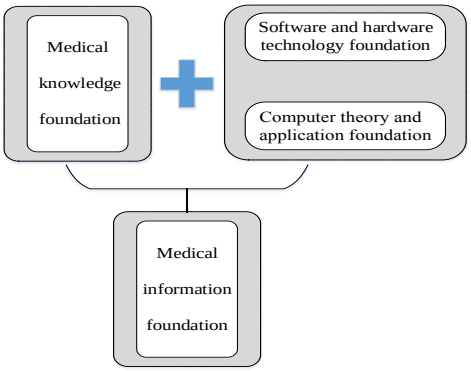

Fig. 1. Core Curriculum Group

C. Cultivation Goal

The training goals of many universities in medical information engineering are to provide students with the basic knowledge of medicine, computer science, technology knowledge and application skills, after graduation, students can work in software development and development of medical and health information systems [13]. The figure below shows the development of students for four years.

From figure 2, we can clearly see that the four-year curriculum system has some links that lack certain connection, which makes it easy for students to ignore the characteristics of medicine. Also, mathematical knowledge courses are not highly connected to courses on computer programming. As for some students who want to further their studies, there is no corresponding postgraduate guidance course, this is what we should pay attention to.

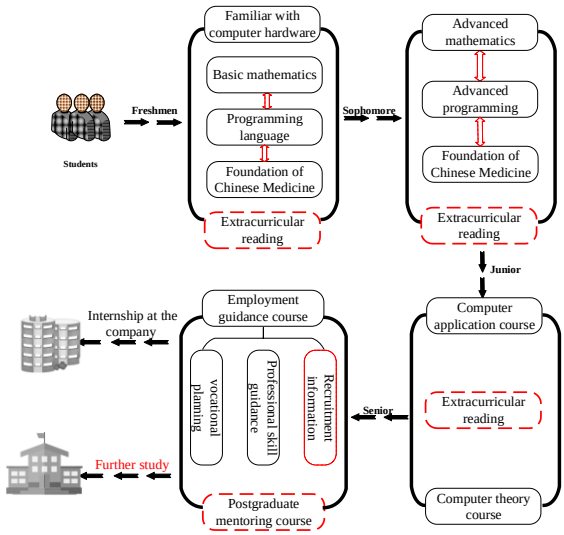

Fig. 2. Training diagram of medical information talents in which red labeling refers to the lack of connection between disciplines, or the absence of relevant courses, or insufficient attention to the corresponding talent training.

TABLE I. CHARACTERISTICS IN GRADE 2015

Employment Characteristic	Responses		Percentage
Work direction	Postgraduate		12.0%
	Job related to this major		56.0%
	Civil servant		10.0%
	Others		22.0%
Organization location	Municipality		20.9%
	Provincial city		53.5%
	Prefecture-level city		18.6%
	County-level city;		7.0%
Required skills	In process of postgraduate study	Basic mathematics foundation	38.1%
		Software and hardware technology foundation	38.1%
		Computer theory and application foundation	4.8%
		Medical information foundation	0%
		Others	19.0%
	In process of work	Basic mathematics foundation	8.9%
		Software and hardware technology foundation	28.9%
		Computer theory and application foundation	28.9%
		Medical information foundation	17.8%
		Others	15.6%

D. Questionnaire Survey

As for the internal students' investigations, we made questionnaires for students in Grade 2015 and Grade 2016 of the school of Information Engineering in Hubei University of Chinese Medicine, which were mainly around the positioning of the professional curriculum. 100 questionnaires were distributed, including 50 seniors and 50 juniors. Multiple choice questions were designed to discuss the development direction of the profession from different angles. At the same time, students' time allocation influences their learning and development. Kevin Fosnacht et al. hold that the way students use their time has implications for their level of learning and development [14]. Qifen Zha et al. studied the relationship between extracurricular time allocation and college students' learning harvest [15]. Hence, we roughly counted extracurricular study time and the physical exercise time of students in Grade 2016.

TABLE II. CHARACTERISTICS IN GRADE 2016

Characteristic	Responses	Percentage
Future position	Postgraduate in this major	50.0%
	Postgraduate in other major	10.0%
	Work in this major	24.0%
	Work in other major	16.0%
Course preference	Basic mathematics foundation	15.9%
	Software and hardware technology foundation	27.5%
	Computer theory and application foundation	39.1%
	Medical information foundation	17.4%
	Others	1.4%
Extracurricular learning (weekly)	3 hours or less	24.0%
	3 to 5 hours	24.0%
	5 to 8 hours	12.0%
	8 to 11 hours	9.0%
	More than 11 hours	31.0%
physical exercise (weekly)	3 hours or less	53.0%
	3 to 5 hours	34.0%
	5 to 8 hours	9.0%
	More than 8 hours	4.0%

Firstly, in table I, many of the students (56.0%) choose careers related to this major, and the working cities are mainly concentrated in provincial cities (53.5%), which is in line with the training objectives of our university. Secondly, the main required skills in process of postgraduate study in table I are to "Basic mathematics foundation" and "Software and hardware technology foundation". While the main required skills in process of work are to "Software and hardware technology foundation" and "Computer theory and application foundation". Furthermore, it is acknowledged that the number of graduate students selected this year accounted for 50%. These data indicate that we should maintain equal attention in the cultivation of applied

talents and academic talents to enable students to make better use of learning resources. Lastly from the distribution of extracurricular time of students in Grade 2016, it can be seen that 48.0% of students concentrate on extracurricular study time within 5 hours per week, and 31.0% of students are more than 11 hours per week. As for physical exercise, the majority of students (87%) exercise less than 5 hours a week.

E. Existing Problem

From the situation of our research, we know that there are still the following problems in the cultivation of medical information talents in our school. ***In curriculum setting:*** Question 1: No courses have been set up to translate basic mathematical theory knowledge into computer-specific algorithms. And lack of application courses that combine Chinese medicine knowledge with computer knowledge, which does not reflect professional characteristics well. Question 2: Students in the university lack of the corresponding extracurricular reading courses, Moreover, extracurricular books that students read after class rarely fail to broaden their horizons. Question 3: In the senior year setting courses, for students who prepared for postgraduate study, there is a lack of corresponding graduate guidance courses; for students who chose to work after graduation, the courses do not conform well to the needs of the enterprises. ***In extracurricular time allocation*:** Question 4: Students' extracurricular learning time is differentiated, and 48% of the total number of students study less than 5 hours per week. And students spend less time on physical exercise, and students who exercise less than 3 hours per week account for 53% of the total number of surveys. How to help students better manage their time? ***In evaluation prospect:*** Question 5: The lack of a corresponding comprehensive evaluation process and the number of evaluations, which did not quantify the four-year performance of students in university.

III. TALENT TRAINING MODEL

According to Skinner theory, which is briefly introduced in the Introduction, it's acknowledged that Skinner's doctrine has not only succeeded in experimental situations, but also has been applied in a wide range of social realities. The concept of reinforcement is originally from the so-called rewards [5]. Skinner gave a new definition of reinforcement in the context of operational conditions. That is, reinforcement refers to an event that is accompanied by behavior and contributes to an increase in the probability of occurrence of the behavior. In the following introduction, we divided the training model of medical information engineering talents into two major parts: the applied talent training model and the academic talent training model. And then put forward the related training scheme.

A. General Type

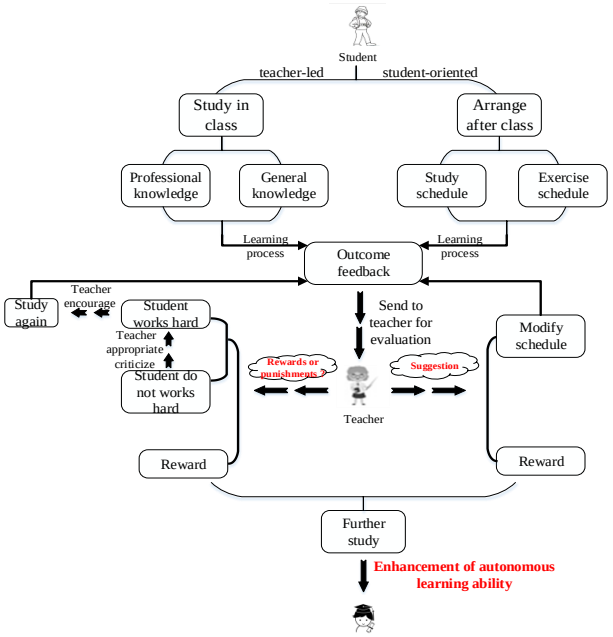

Fig. 3. Talent training model base on Skinner theory

As we know from Figure 3, the cultivation of our talent training model is mainly divided into two sections: teacher-led learning in class and students' autonomous learning after class. In the course of the student's learning process, it is necessary to promptly feedback the knowledge to the teacher, and then the teacher makes a corresponding evaluation based on the feedback of the student—whether it is reward or punishment; In the course of the student's learning process, it is necessary to promptly feedback the knowledge to the teacher, and then the teacher makes a corresponding evaluation based on the feedback of the student—whether it is reward or punishment. In the process of students' self-learning, students may encounter problems (such as how to allocate time reasonably). Students should promptly give feedback, and then teacher gives suggestions. Finally students adjust the schedule to achieve efficient learning. The combination of in class and after class can enhance students' ability to learn independently.

Based on the questions and training model raised above, we give the concrete solutions. The following research hypotheses were formulated in the figure 4.

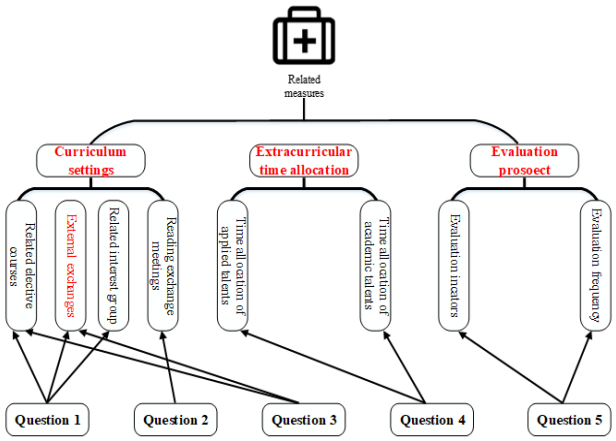

Fig. 4. Solutions to existing problems

From the above picture, we can get the measures from question 1 to 5. For question 1, some elective courses can be added appropriately such as mathematical analysis and other courses. Also, we can carry out some research interest groups, and some external exchange activities (such as participating in modeling competitions, etc.). For question 2, it is necessary to enrich students ' thinking by setting up relevant reading appreciation classes. For question 3 and question 4, we need to categorize students as: applied talent and academic talents, which we would subdivide in the next section. For question 6, some evaluation indicators and number of evaluations can be set to see whether the students have gained at a certain stage, and we will present it in the part of the evaluation. Lastly, we hope to establish a corresponding information publishing platform, which enable students to obtain the information they need in a timely manner. The concrete procedure is: students log in to the platform→find activities (e.g. scientific research lectures, research group recruitment, college student competition information and elected courses etc.) →submit applications and relevant proof materials. Through the intermediary of the platform, students can better use resources to learn and improve their abilities.

B. Applied Type

The difference between applied talent model is that it emphasizes student-oriented, the general steps are: students understand the needs of the outside world (such as the corresponding job skills) →learning→encounter problems→ask the teacher to help→teacher gives solutions→students feedback whether knowledge is mastered. The corresponding solutions are shown in Figure 5.

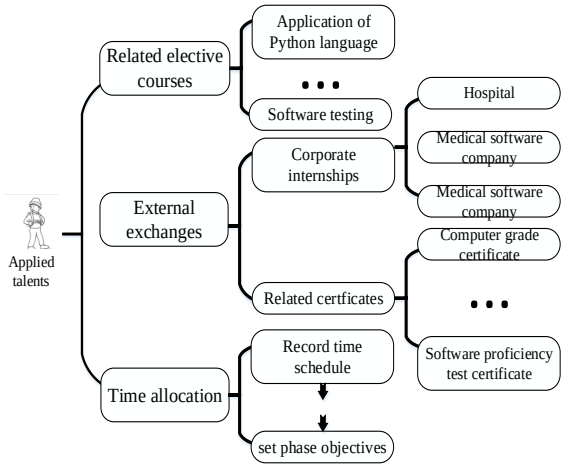

Fig. 5. Measures related to applied talents

For the solution of applied talents, it can be divided into 3 parts: 1. Increase the number of elective courses (through the MOOC network study, or the teacher's offline teaching etc.) 2. Participate in external exchange activities (enrich both work experience and related certificates) 3. Define time allocation, regularly develop schedule and meet the milestones of applied talents.

C. Academic Type

Under the guidance of Skinner theory, the academic talents at the undergraduate level are guided by a teacher-led model, the general steps are: teachers provides the research direction to the students→students access the information and choose the direction they are interested in→teachers provide relevant literatures for students→students regularly report their achievements. What is discussed here is the solution for academic talents. The specific measures are described in the following figure.

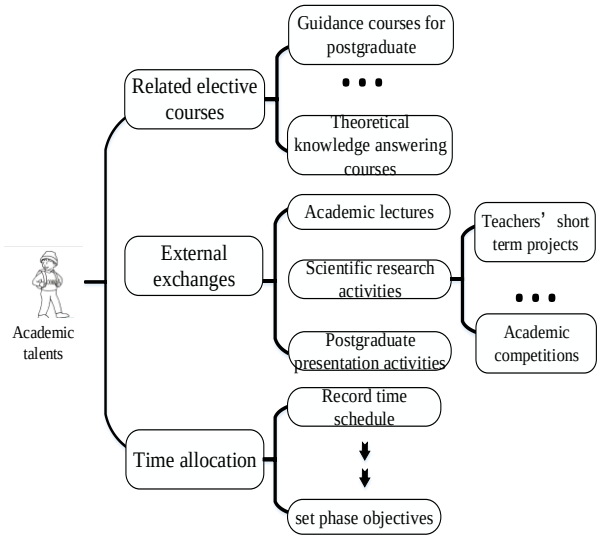

Fig. 6. Measures related to academic talents

Just like the solution for applied talents, academic talent is also divided into 3 parts: 1. Appropriately increase the elective courses that are conducive to reviewing the preparation for the entrance examination of postgraduate. 2. Increase the corresponding academic activities (such as scientific research competitions and projects) to improve students' scientific research abilities. 3. Define time allocation, regularly develop schedule and meet the milestones of academic talents.

IV. TIME MANAGEMENT MODEL

We can see the time distribution survey of extracurricular study and physical exercise of students in Grade 2016, the majority of them don't make effective use of their extracurricular time. Many experts at home and abroad have pointed out that reasonable extracurricular time allocation is quite helpful to cultivate students ' learning ability. For some instances, Steven Brint et al. found that study time had a strong connection with both academic conscientiousness and higher grade point averages. And physical exercise were also associated with higher levels of academic conscientiousness [16]. Qifen Zha et al. held that extracurricular study time had a greater impact on learning gains than extracurricular part-time [15].Hence, we conduct a specific method to help students better allocate time. The concrete procedure is in the following figure 7.

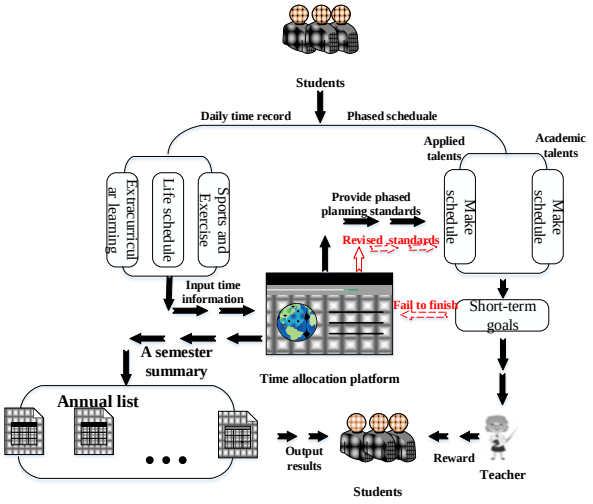

Fig. 7. Time manage model

The model we have proposed is divided into two-time granularities: daily and short term (for example, one week). For the daily distribution of time, students can enter the time platform to summarize after one semester, just like Ali's annual bill, which can clear about the time flow. For phased time allocation, students (academic and applied) can assign their own schedules based on the time allocation templates, and then develop their own schedules to complete recent tasks.

V. PERFORMANCE EVALUATION

Our training model is aimed at students of medical information engineering in Grade 2016. Currently, they are in the process of cultivation and judgment by setting the evaluation indicators, which are shown in table 3.

TABLE III. EVALUATION INDICATORS LIST

indicators	description
Self-efficacy	how confident students felt about their ability to learn and successfully complete their coursework.
Consistency of interest	students' self-reported tendency to stick with particular goals over longer periods of time.
Academic achievement	students shared the number of courses they were currently taking in which they expected to earn
Course performance	distribution of grade points of the student's grades in one semester
Time management	the extent to which students believed they used effective strategies for academic scheduling and regulating where they studied
Procrastination	students' reported tendency to delay making decisions, begin tasks, or miss deadlines for their academic work.
Motivation	assess students' beliefs and attitudes regarding school or learning in general rather than a specific course

In the setting of evaluation factors, we referred to the setting of evaluation factors by Wolters et al. [17]. Through these evaluation factors, we can see the changes after the cultivation of new talent models. In the following work, we will set the relative weight of different evaluation factors to improve our evaluation mechanism. As for the number of evaluations, we conducted a total of four evaluation, and students conducted an evaluation before entering the school, followed by an evaluation in each academic year, in the end, a final assessment of applied talent and academic talent after a talent diversion in senior years.

VI. CONCLUSION

First of all, we conducted relevant research, starting from the historical background of medical information engineering, understanding the training of medical information talents in universities, and learning from foreign schools that offer majors related to medical information, then we found that the training level of medical information talents in China mostly in the undergraduate stage, only a small part of research universities offer Master's degree about medical information. After that, the relevant investigation was done to understand the overall situation of the students in this field. From the results of the investigation, we designed the corresponding talent training model based on Skinner theory, and in the solution measures we divided the talents into academic and applied types. At the same time, in addition to some suggestions in the course settings, we also established a time management model to understand the student's time allocation through two-time

granularities (daily and short term) to help students make effective use of time. Finally, we designed the related evaluation factors and the number of evaluations. At present, we have not set the corresponding weight of the evaluation factors, which we have to do the work later.

In the future, on the one hand, we hope that our talent training model can be achieved. On the other hand, we can design the corresponding software of time management allocation platform to help students better use time.

ACKNOWLEDGEMENT

This paper is supported by Research Project of Provincial Teaching Reform in Hubei Province (#2017356)

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