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University Teaching and Research and Scientific Research Performance Quantitative Statistics System Based on Web

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Abstract

After implementation of the merit pay, the quantity and quality of teaching staff's scientific research projects, papers and monographs, teaching reform projects, teaching achievements would definitely affects their post promotion and appointment and salary treatment, etc. The current office automation system, education administration management system, scientific research management system mainly focused on daily office use, teaching and scientific research business process and daily affairs processing. It is unable to provide scientific quantification, accurate statistics and decision support for the teaching research projects and scientific research projects. As for these cooperation projects involve multiple majors and departments, repeated recording, repetitive statistics, missing statistics or misinformation are easy to happen and that will affect the statistical results. With all kinds of information of teaching research and scientific research projects (data) doubly increases and constantly changes year by year, there is a tough problem that the university administrator and decision-making departments are facing. How to standardize the entry (or batch import) of research data, and realize multi condition query and dynamic update? And how to realize the implementation of teaching, scientific research merit automatic quantification, distribution according to proportion, and do automatic summation by name. "University teaching and research and scientific research performance quantitative statistics system based on Web "emerges as the times require. This project aims to develop a set of network management system with multiple users and graded rights, which embodies teaching research scientific research project, standardized management, merit points, automatic quantification statistics, data analysis and warning and report output. Its accurate and fast statistical results can provide the decision-making basis for their department annual summary, and parts of the system module can be applied to other universities after slightly modified.

Keywords: *Teaching and research performance; Scientific research performance; Performance quantization; Distributive performance; Performance statistics*

1. Introduction

Conforming to the trend of the national education reform, the university scale continues to expand, and forced personnel and distribution system reform was speeded up. The State Council decided that the public colleges and universities adopt the merit pay from 2010 onwards. Gradually, faculty on campus would change from identity management to post management. A merit management system matched to the post appointment system is established. Under this system, the quantity and quality of teaching staff's scientific research projects, papers and monographs, teaching reform projects, teaching achievements and awards would definitely affects their post promotion and appointment, thus, management departments at all levels are supposed to quantify faculty's project information like

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teaching research, scientific research and achievement awards and other projects into merit points, conduct further statistical summation and assessment grading.

Almost all study subjects are done by multi-person collaboration. In that way, how to realize "encouraging cooperation, embodying difference" in the process of points distribution? How to ensure high efficiency between professionals and put a stop to the existing nominal phenomenon? How to realize the accuracy, high efficiency, and automation of the teaching research, and scientific research merit quantification, and distribution and statistic summation? These are tough problems that the colleges' management and decision-making departments are facing, because the quantification statistical results are related to the vital interests of all the teachers.

Literature [1] introduced the statistic management and system implementation of conventional teaching workload, such as teachers' classroom teaching, experiment teaching, assistant teaching and class hours reduction; literature [2] gives the calculation formula of a year teaching workload W: W = ∑standard hours of theory course + ∑standard hours of practical course + graduation standard hours - workload deduction. At the same time, rules say the total annual individual teaching workload cannot exceed 700 standard hours in principle. Exceeded hours are calculated as 30 percent off. Namely, the annual teaching workload calculation formula is revised as:

$$\mathrm{TW} = \begin{cases} W & (W \le 700) \\ 700 + (W - 700) \times 0.7 & (W > 700) \end{cases} \quad (1)$$

Neither literature [1] nor literature [2] cover the merit points quantification and distribution of teaching research and scientific research. Literature [3] gives a formula "workload = teaching workload + guiding workload + scientific research workload". In which, teaching workload is the total convert workload of all the courses that the teacher are teaching. The guiding workload is determined by the number of students and nature that the teacher are guiding; scientific research workload is determined differently by the scientific research tasks the teacher mainly undertakes; however, the paper gives only the teaching workload and guiding workload calculation formula, and hides the calculation algorithm and allocation method of the scientific research workload. Literature [4] gives the calculation formula "the total workload = the total number of class hour + subject coefficient ×the total number of subjects + paper coefficient X the total number of papers, and it gives the corresponding allocation algorithms: Wherein, the subject coefficient of the subject host is 200 (cooperator point is decided by the system in descending, 50 points less than each, namely NO.2 get 150 points, NO. 3 get 100 points, and so on). The paper coefficient of the monographer is 20 (first author is 15; collaborator point is given by the system -5 points in descending). Although the total workload covers the teaching research merit, and the distribution method embodying some difference, the total point of subjects and papers is unlimited, it tends to develop nominal phenomenon; literature [5] put forward academic journal index quantification mathematical model on the basis of analyzing the index factor and weight of university academic paper, such as the equation (2) below (C_i indicates the corresponding weights of the journal level, successively, it gives value of 0.54, 0.26, 0.13, 0.07; B_1 is the corresponding weight of the cited papers index, and it's given value 0.6; B_2 is the corresponding paper weights of supplementary issue or album, and it's given value 0.4; Xα1 is the number of published papers on the corresponding journal, Xα2 is the number of published papers on the supplement or album):

$$X_\alpha = \sum_{i=1}^{4} C_i (B_1 X_{\alpha 1} + B_2 X_{\alpha 2}) = \sum_{i=1}^{4} C_i (0.6 X_{\alpha 1} + 0.4 X_{\alpha 2}) \quad (2)$$

In the literature [6], research work calculation method and teacher's scientific research merit evaluation, the two models are proposed. The total amount of the research work $M=\sum_{i=1}^{n} M_i$ was determined, however,

$$M_i = \begin{cases} K_{RT} X_i & (1 < X_i < a) \\ K_{RT}[(a-1) + \log_a X_i] & (X_i > a) \end{cases} \quad (3)$$

Therein, a denotes the received research funding number equaled to the amount of teachers' annual standard teaching workload. $X_i=A_i \cdot K_1 \cdot K_2 \cdot K_3 \cdot K_4 \cdot K_5 \cdot K_6 \cdot K_7$ computes research funding number, A_i means the actual arrived funds for the number i scientific research project during the teachers' assessment period. $K_1 \ldots\ldots K_7$ denotes the project source coefficient, project category coefficient, project technical difficulty coefficient, project belonged subject coefficient, project member professional title coefficient, project members constituent coefficient (full-time or part-time), project completion coefficient of the number i scientific research project. K_{RT} means the convert coefficient of the scientific research workload and teaching workload.

The evaluation value calculation formula for teachers' scientific research merit is $W=W=J_1W_1+[J_2W_2+J_3W_3+J_4W_4+J_5W_5+J_6W_6+J_7W_7] \cdot Z$, where Z is the convert coefficient for title, $J_1 \ldots J_7$ is an index quantification processing coefficient and $W_1 \ldots W_7$ denotes the research task assessment value, research monograph assessment value, academic paper assessment value, scientific and technological achievements appraisal assessment value, prize of scientific and technological achievements assessment value, patent achievement assessment value, research benefit assessment value. Although literature [5-6] quantified academic papers and scientific research projects, signature sequence cannot be distinguished, and difference cannot be shown

From the existing literatures, it is observed that, there are a lot of quantification and assessment grading researches on college and university teaching workload and scientific research workload. However, researches on point's distribution after quantification are not so much. Some distribution algorithms (such as unlimited calculation) are vicious, the distributed point statistics and summation fail to be done efficiently and automatically with the help of system management. As the current university educational management system can greatly accomplish the curriculum arrangement and teaching workload statistics, this thesis focuses on the management business flow for college and university teaching research and scientific research. It is carefully designed for all kinds of project quantification index and allocation algorithms. It is supposed to research and develop a set of network management system involves teaching research and scientific research standardized management (input, query and modify), project merit quantification and automatic distribution, point summation and statistics and analysis, statistics form output. The standardized management system contains educational reform, course construction, teaching awards, research projects, papers and monographs and academic awards. And the network management system can be used by multiple users and graded rights.

2. Design Idea and System Structure of Quantization Statistical Management System

2.1. Design Idea of Quantization Statistical Management System

1) A three-tier hierarchical mixed structure based on browser /server and client /server

It is designed as three-tier structure Based on the mix of B / S and C / S: it suits for information inquiry and organization; it provides different levels of service; it reduces the burden on the client-side and data server, and provides high efficient merit.

2) Using JAVA/JSP+ Tomcat 6.0+ Mysql5.0 as the development environment

Java Servlet Pages is a dynamic web technology standard developed by SUN. A JSP page requires Java program fragment and JSP tags be put in traditional static page file (*.html, *.htm). JSP is compiled once in the Servlet category and be stored in memory. Subsequently, it can be called quickly without recompiling. MySQL is open source software, so it is suitable to access to the database on the Internet, with high connectivity, speed and safety.

2.2. System Structure of Quantization Statistical Management System

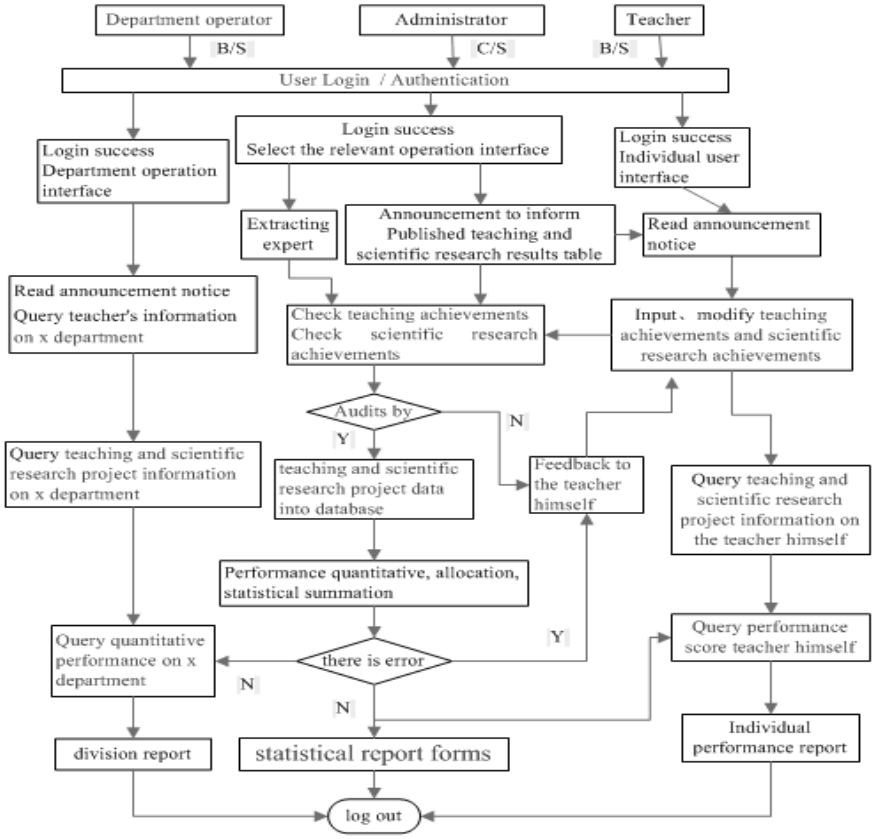

Figure 1. System Business Flow Diagram

The quantification statistics management system is for college staff, audiences are divided into three types of users with different privileges: course teachers and researchers, college administrators and system administrators. Using this system, course teachers and researchers can query relevant notices and bulletins; typing in (submit) one's project information for administrators to audit. When the project is approved, the quantification and distribution can be done by the system automatically (through the default mode), or be manually done by the project leader. And course teachers can query their participated project information and point situation. College administrators mainly use it to query, count, outputting report information of teaching research and research projects. The system administrator realize user management, bulletin notice publish, project information audit, point

quantification and distribution, point counting, early warning and outputting report and other functions. According to the description, system business process is shown as Figure 1:

3. Main Function Modules and Realization of the Quantization Statistical Management System

According to the operation flow, the quantization statistical management system is divided into teaching research project management module, scientific research project management module, project merit point quantization module, project point distribution module, project point statistical and early warning module, user management module, bulletin information management module, system maintenance module, *etc* [7-9]. In the following passage, we focus on the implementation of three core modules: teaching research and scientific research merit point quantification, point distribution and point statistics.

Table 1. The Merit Point Quantification of Teaching Research Project

Assessment content	indicators for merit assessment		points	remark
teaching reform project	* National teaching reform project		2000 points/term	project approval 40%,Final report 60%
	* provincial teaching reform project	Key funding	500 points/term	
		General funding	300 points/term	
		Self-raised funding	100 points/term	
	school-level teaching reform project	Key funding	150 points/term	
		General funding	80 points/term	
course construction	* National excellent course		1000 points/term	project approval 30%, in-process inspection 30%, Final report 40%;if it is curriculum group, the whole points times 1.5
	* provincial excellent course		300 points/term	
	school-level excellent course		50 points/term	
	school-level key course project		100 points/term	
	course outline writing		5 points/ course	grade once
Professional and demonstration center construction	* National brand characteristic major		1000 points/term	project approval 50%,Final report 50%
	* provincial brand characteristic major		300 points/term	
	school-level brand characteristic major		50 points/term	
	New major reporting and construction		100 points/term	success reporting 50 points; major construction period is 3 years:1st year 30 points, and 10 points for the 2nd and 3rd year
	Development of a training plan		20points/major	grade once
	Professional evaluation	* National professional evaluation	1000 points/term	
		* provincial professional evaluation	300 points/term	
	* National experimental teaching demonstration center		1000 points/term	project approval 50%,Final report 50%
	* provincial experimental teaching demonstration center		300 points/term	
	school-level experimental teaching demonstration center		50 points/term	
Teaching material	National planning textbook		300 points/ type	Accomplished by the university, grade once; if accomplished by multiple universities (not exceeding the total point) the chief editor 50%, subeditor 30%; participants 10: each chapter.
	Public publication material		160 points/term	
Teaching award	guiding teacher for excellent graduation design (paper)	* provincial award	60 points/term	grade once
		school-level award	20 points/term	
	teaching team	* National	1500 points each	40% project approval 30%, in-

		teaching team		process inspection 30%, Final report 40%
		* provincial teaching team	500 points/term	
		school-level teaching team	200 points/term	
Subject competition, second classroom, sports competitions, *etc*.	* National	* First Prize	60 points/term	grade once; as for the same one, calculate the highest points, once
		* Second prize	50 points/term	
		* Third Prize	40 points/term	
	* provincial	* First Prize	30 points/term	
		* Second prize	20 points/term	
		* Third Prize	10 points/term	
Teaching Achievement Award	* National	* National First Prize	1600 points/term	grade once
		* National Second prize	1000 points/term	
		* National Third Prize	600 points/term	
	* provincial	* provincial First Prize	300 points/term	
		* provincial Second prize	200 points/term	
		* provincial Third Prize	100 points/term	
	school-level	school-level First Prize	80 points/term	
		school-level Second prize	50 points/term	
		school-level Third Prize	30 oints/term	

3.1. Merit point Quantization of Teaching Research, Scientific Research and other Projects

University research work priority evaluation model can be described by the following formula [10], [11]:

$$f(R,S,T)=\alpha R+\beta S+\gamma T \quad (0\leq A, B, C \leq 1) \tag{4}$$

Wherein, R is the demand degree volume, S is the strength relative volume in university; T is the level membership; α, β, γ, respectively represents the weight of the three. R is the demand degree of the overall objective on various disciplines (projects). That is, to achieve the overall objective and develop a priority area, to the benefit of the achievement of the overall objectives. Each area represents a weight, and record it as R. S is the occupied share of owned strength of a field in the strength of a university. T is the gap between the practical level of a certain area and the higher level of the same field in the overall target layer. Weights α, β, γ can be calculated by Delphi method, AHP and fuzzy theory. According to relevant documents and evaluation models, the merit point quantification of teaching research project is as shown in Table 1:

3.2. Points Allocation of Projects Like Teaching Research, and Scientific Research

As for teaching research projects are mostly done by cooperation, in order to achieve “encouraging cooperation, embodying difference" this quantification statistical system adopts the following formula to calculate the points of each person [12-13]:

$$X_1=\frac{N^2+N+2}{2N(N+1)}P,\ X_2=\frac{2(N-1)}{N(N+1)}P\ \ldots,\ X_S=\frac{N-S+1}{N(N+1)}P \tag{5}$$

X_1, X_2, X_S separately represents the gained point of the NO.1, NO.2 and NO. 3(s≥3), N is the total number of people, P is the total points of the project.

Formula (4) meets two constraint conditions:

1) P representing the total point of each item, is a definite quantity. This means, the more participants are involved in a project, the less actual points the host gets. In that way, the host will spontaneously optimize his team. To some extent, it avoids nominal drawbacks.

2) The ranking points of each project should maintain an appropriate ratio. Examples are as follows:

X1 and X2 are related as the following:

When N = 2 or 5, X1 = 2X2; when N> 5, X1> 2X2

When 2 <N <5, namely, N = 3 or 4, X1 <2X2

N is an arbitrary value, X1> 3X3, X1> S Xs

Points of participating in S projects and get NO.S could be more than hosting one project, things like this would be avoided (except when N = 3 or 4, $X_1<2X_2$, the reality is the second doer often turns out to be the main member of the subject). And this is how we "encouraging cooperation, embodying difference".

After defining the point distribution formula, we begin to design point distribution calculation: the member points of the projects like teaching research, and scientific research are stored in a separate database table. In which, it includes 11 fields like the project id, total points, total points when project approval, in-process inspection, total point when final report, setting up time, in-process inspection time, final report time, member points when project approval (format: member name 1: points 1 & name 2: points 2, ...), in-process inspection member points and members points of final report.

First of all, the condition for point distribution is, the project setting up time not being null. When the condition is met, the distribution interface would be displayed. In the member point box, the points would be calculated by equation (4) loaded (when the host needs to be amend the member point, the box can also be manually entered). Only when all the member points equal the available merit points, can the system submit the data. Before submitting, the data will be preprocessed. Namely, to integrate all the member point into an alphabetic string, so as to convert it into a format like: member name 1: point 1 & Name 2: point 2…. At last, insert the point data into the corresponding data table to complete the project point assignment. Point assignment algorithm flow chart is shown in Figure 2:

According to the point assignment algorithm, we get the point assignment key code segment for the teaching reform, it is shown as follow:

```
void AssignMemberJiFen(Jiaogai_Info ji){
int flag = false;
MemberJiFen mjf = new MemberJiFen();
if(ji.isLixiang()){
while(!flag)
flag = assignlixiangjifen(mjf);  }
else
if(ji.isZhongJiang()){
flag = false;
while(!flag)
flag = assignzhongjiangjifen(mjf);  }
else
if(ji.isJieTi()){
flag = false;
while(!flag)
flag = assignjietifen(mjf);    }
insertDB(mjf);
}
```

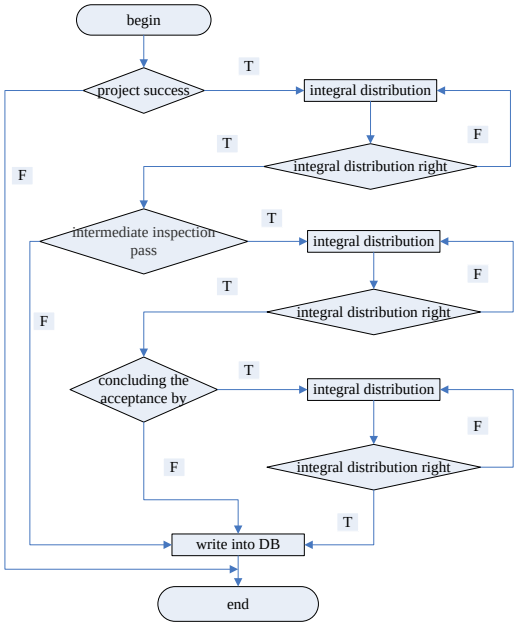

Figure 2. Point Assignment Algorithm Flow Chart

3.3. Point Statistics for Projects like Teaching Research, and Scientific Research

Considering the actual functional requirements and system response times, this quantification statistical system uses a three-dimensional array to realize the statistics and summation function of teaching research merit points of teachers in a department during one year (the three-dimensional array can be described as being constituted by a one-dimensional array and a two-dimensional array[14-16]. The one-dimensional array stores the names of teachers, the two-dimensional array stores the name of responsible person and personal points), it is shown in Table 2 below:

Table 2. Merit Summary Sheet of xx University

xxxx year xxx university merit summary table												
NO.	name	merit points	Project 1		Project 2		Project 3		Project 4		Project 5	
			Project 1	points	Project 2	points	Project 3	points	Project 4	points	Project 5	points
1	XXX	199.0	XXX	75.0	XXX2	53.0	XXX3	37.0	XXX4	24.0	XXXX	10.0
2												

Merit point statistic summary algorithm is shown in table 3:

Table 3. Statistic Summary Algorithm of Merit Points

Algorithm: statistic summary algorithm of merit points Input: teaching research project, time, belonged department dept Output: Summary results of merit points
● The first step: to retrieve all department teachers' information from the database, record it as teachers[num], where num is the number of teachers, and store it in a Map object result <key, values>. In which, key is the teacher's name, and total merit points. Values are the responsible person and personal point. make the counter i = 0, total merit points = 0, skip to the next step; ● Step 2: If i is less than num, search the qualified member point data set according proj, time and teachers [i] from the database, record it as pointsult. If pointsult is not null, skip to the next step. Otherwise i = i + 1, continue the second step; otherwise, skip to step 4. ● Step 3: If pointsult traversal is not ended, read the next pointsult record. Truncate the point including teachers[i],

selfpoint and responsible persons. Set total = total + selfpoint, resp & selfpoint as value, and add value to the values, continue the third step. Otherwise, set the teacher [i] & total as key, and add values to the result, moreover, i = i + 1, skip to the second step;

- Step 4: The algorithm terminates.

According to the statistic summary algorithm of merit points, we get the key code segment of the gained teaching and scientific research project point during a certain period of time, it is shown as follow:

```
Map<String key, ArrayList<String> values> Huizong(String proj, String time, String dept)
{ Map<String key, ArrayList<String> values> result = new HashMap<String key, ArrayList<String> values> ();
ArrayList<Teacher_Info> teachers = getTeacherList(dept);
int num = teachers.size();
int i=0;
float total = 0;
while(true){
if(i<num){
ArrayList<MemberJiFen_Info> scoresult = getMemberJiFen(proj, time, teachers.get(i));
if(scoresult!=null){
String name = teachers.get(i);
ArrayList<String> values = new ArrayList<String>();
for(MemberJiFen_Info mji: scoresult){
float selfscore = mji.getSelfScore();
String resp = mji.getResp();
total = total + selfscore;
String value = selfscore.toString()+"&"+resp;
values.add(value);  }
result. put(teacher[i]&total, values);          }
i= i + 1;
}else
break;  }
return result;  }
```

4. Conclusion

After a test run, the management system is stable. With the rapid development of information technology construction in universities, the type and quantity of teaching and scientific research projects are changing dynamically (for example, new provincial excellent resource sharing classes be added in teaching research projects, provincial collaborative innovation center, provincial university Party construction and research projects and the provincial Sports Bureau research projects, *etc* be added in the scientific research). Thus, we need to modify relevant functional modules in time appropriately; follow-up study will focus on the construction and improvement of the assessment and warning module!

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