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Changes in workload of Chinese university undergraduate teaching from the perspective of education quality management: A case study of a teaching-research university

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Abstract. The teaching workload of university teachers is an objective reflection of their instructional input and directly affects the quality of education and teaching. The ultimate goal of studying university teachers' workload is to enhance the quality of higher education. Based on the analysis of data from twelve years' teaching workload of a teaching-research university in China, the results show that the changes of overall teaching workload are in stages. Classroom teaching workload is the majority of the whole teaching workload. The teaching workload is mainly undertaken by university teachers with intermediate and deputy senior professional titles, and changes in teaching workload undertaken by university teachers with junior professional title and intermediate professional title is greater than those with vice senior professional title and senior professional title. Male teachers' workload is slightly more than female teachers, but gender differences have been shrinking over the years. The proportion of classroom teaching workload in teaching-oriented colleges is high, which is about 7:3 and has decreased in the past twelve years. Developing logic, administrative logic and difference logic are generative logic of changes in undergraduate teaching workload. Due to the relevance of the ISO 9000 family of standards in the management of higher education teaching, it is recommended to follow its seven quality management principles and adopt a teaching quality management approach based on the PDCA cycle in a broader context of quality management. This approach aims to manage higher education systematically, establish an organizational environment, and promote teachers' active engagement in teaching, including teaching workload. It also facilitates to improve teacher classification management and evaluation mechanisms.

Keywords: Undergraduate teaching workload / change characteristics / generative logic / teaching-research university / ISO 9000

1 Statement of problem: the teaching workload of teachers is closely related to the quality of higher education

Quality is an eternal theme in the development of higher education in various countries, and undergraduate education and teaching are the constant core of talent cultivation. Our previous research has found that university teachers are the most important factor influencing the quality of undergraduate education. Factors such as teachers' sense of teaching responsibility and teaching efficacy significantly impact their teaching dedication [1]. Generally speaking, teachers' teaching input is positively correlated with their teaching quality. In other words, the more teachers invest in teaching, the more improvement there will be in the quality of education. However, for a long time, teaching has been marginalized in the field of higher education that emphasizes research performance, and the insufficient investment in undergraduate education has become a key issue affecting the quality of higher education. In the 1990 s, American researchers revealed that as the emphasis on university teachers' discretionary time increased, they devoted more time and energy to research, resulting in less attention being given to undergraduate teaching [2]. In China, one of the key issues faced during the process of enhancing the construction of high-quality undergraduate education is the inadequate investment of university teachers in teaching [3].

Time is the foundation on which all human activities are conducted, and it is the prerequisite and basis of teaching investment. The investment of teaching time is an essential factor and guarantee for the teaching investment of faculty members. The teaching workload is an important indicator to measure teaching time investment of faculty members. The working hours of faculty members can often

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be expressed as or even equated with teaching load. In 1969, the Statement on Faculty Workload with Interpretive Comments issued by the American Association of University Professors (AAUP) used the expression "teaching loads", and the "faculty workloads" are considered to be the weekly formal classroom teaching time, or more accurately, "course loads" or "teaching hours" [4]. Meyer directly defines faculty workload as the time spent on appropriate professional activities [5]. As an indication of how much work a faculty member does, faculty workload is measured by the total weekly time on teaching, research, administration, and public service [6]. It is thus evident that teaching workload, as an expression of the quantity of teaching tasks, is a manifestation of faculty's teaching hours.

The teaching workload of university teachers is an objective reflection of their instructional input and directly affects the quality of education and teaching. The appropriate teaching workload reflects the rational allocation of resources in universities, which can motivate enthusiasm of faculty members to teach and promote students' progress. For universities, abnormal expansion of teaching workload will waste human and financial resources, while an excessive reduction will not meet the needs of student development. For faculty, a too high or too low teaching workload usually reduces their teaching preparation time, causes negative emotions, affects physical and psychological health, and even hinders professional development. These problems affect the efficiency and quality of teaching in universities. Therefore, research on faculty teaching workload is means to achieve a more important purpose: to improve teaching quality of higher education.

Teaching workload is the amount of teaching that has been done or should be done by a faculty member and can be expressed precisely in numerical terms. In 1955, the Chinese Ministry of Higher Education issued the Trial Measures on Workload and Working Days for Faculty in Higher Education Colleges, which clearly defined the teaching workload to be completed by faculty in higher education colleges throughout the year and the corresponding calculation methods. Teaching workload has since become an essential system in faculty management. Due to the fact that the national-level faculty workload management methods cannot be applied to different levels and types of higher education colleges, so the authority to manage faculty workload was devolved to higher education colleges in the 1980 s, and the formulation of faculty teaching workload has become an internal affair for universities.

In the classification of Chinese universities, there are two main approaches. One approach roughly divides universities into four categories: research university, teaching-research university, teaching university, and vocational university; the other approach categorizes universities into: research university, research-teaching university, teaching-research university, and teaching university, both of which are influential. Teaching-research universities are an important type among Chinese higher education colleges. Therefore, this study takes University A, a teaching-research university, as a case and analyzes the data on teachers' teaching workload from the academic year 2008–2009 to 2019–2020, revealing the change characteristics and generative logic of changes in teachers' teaching workload.

Since the workload is closely related to teaching quality, it is important to view the study in a broader context. In particular, the latest version of ISO 9001:2015 international quality management systems has been followed, which includes seven quality management principles, i.e., customer focus, leadership, engagement of people, process approach, continual improvement, evidence-based decision making, and mutually beneficial supplier relationship. This study proposes strategies and methods for continual improvement and enhancement of teaching quality in higher education by implementing the PDCA cycle of process control. The aim is to provide a reference for educational management in higher education worldwide, enrich the study of university faculty' teaching input from a cross-cultural perspective, and ultimately contribute to the improvement of the quality of higher education teaching.

2 Literature review

2.1 Structure of faculty's teaching workload

Foreign research on teaching workload began in the early 20th century, with early studies focusing on faculty workload. Koos published the first paper on faculty workload, which stated that teaching time is available to comprehend all the work of a faculty member, including time spent in class, in preparation for class sessions, and in reading papers or doing other work connected with such class sessions, and it also includes the time spent in the supervision of students working on individual research problems [7]. It can be seen in the early studies that faculty's workload was understood from a narrow sense, with teaching workload being seen as everything of workload. However, understanding of teaching workload's structure already included many contents. Most subsequent research has also provided a broad understanding of the scope of faculty teaching workload, and the definition of its scope has been continually adjusted. Yuker stated that teaching time refers to all the time associated with teaching activities, such as the time of classroom teaching, teaching preparation, exam preparation and so on [8]. It is thus clear that the structural content of the teaching workload of university faculty is dynamic and constantly evolving.

The focus on faculty teaching workload in China started from the faculty workload system. Teaching workload schemes for higher education introduced in 1955 and 1963 respectively failed. In 1979, Interim Provisions on the Duties and Assessment of Faculty in Higher Education Colleges state that the teaching work can be divided into ten areas: lectures, tutorials, discussions, exercises course laboratory sessions, internships guidance, graduation thesis and design supervision, textbooks compilation, teaching methods research, postgraduate guidance and training courses for faculty members. It later also added four more aspects: cause work marking, design guidance, social investigation guidance, and examination and assessment.

Researchers have also explored the structure of the teaching workload from an academic perspective. Teaching workload mainly refers to the work directly facing students in order to complete the teaching task, such as lectures (including lesson preparation, lecturing and extra-curricular tutorials), tutorial classes, exercise lessons, class discussions, course work marking, laboratory lessons, revision tutorials, social surveys, supervision of projects, dissertation, course designs, final year project designs, final examinations, tests and pedagogical research [9]. With the development of higher education, new teaching contents have started to emerge, such as undergraduate students' participation in research activities and various student competitions. Time investment in teaching includes four main components: class time, preparation time, practical teaching and teaching-researching activities [10]. Compared to previous studies, guiding students in scientific research projects and other scientific activities or competitions were added to the practical teaching time. In summary, it is clear that the structure of university faculty teaching workload varies according to the educational content and the perspective of the researcher.

2.2 Faculty's teaching workload levels

The level of teaching workload directly reflects the investment of faculty teaching work and is an important measure of their teaching investment. Investigations of faculty workloads in higher education colleges began early in the United States.

In 1992, the University and Community College System of Nevada (UCCSN) conducted a survey on the workload of all full-time faculty members in the system during the fall semester. The survey found that community college teachers spent an average of nearly 46 h per week, or 77% of their time, on activities related to teaching. Their counterparts at the University of Nevada, Reno (UNR) and the University of Nevada, Las Vegas (UNLV) reported spending an average of 35 hours per week, or 60% of their time, on teaching-related activities [11]. Some studies point to differences in the teaching workloads at different types of colleges and universities: "The course load of American university faculty averages about 6 classes per week at research universities, 8 to 10 classes per week at four-year universities, and 14 to 16 classes per week at junior colleges" [4].

Regarding the class teaching workload of Chinese university faculty members, a study found that faculty members with senior professional titles have less teaching workload, and nearly 2/3 of professors and 1/3 of associate professors have 4–6 h of undergraduate teaching per week [12]. A teaching workload research found that in 2012, there were significant differences in the workload among different teaching departments in a university [13].

Existing studies usually investigate and compare the time and proportion spent by faculty members on each part of teaching and research work. Overall, these data on teaching hours ranged from 8.7 to 45.8 h, and the proportion of total work hours ranged from a low of about 26% to a high of about 77% [11,14,15], and these surveys were based largely on current data obtained in a given year. So, whether does the investment of faculty teaching hours change with time, and what changes do faculty teaching hours have over a given period? Data from National Center for Education Statistics show that between 1987 and 1992, the percentage of time full-time faculty members spent on teaching decreased (from 57% to 54%) [16]. The average time spent per week by Japanese faculty members on teaching was 19.7 h in 1992 and 20.4 hours in 2007, with no significant change [17]. Undergraduate teaching hours of Chinese faculty members were 11.8 h in 2007, and were reduced to 8.7 h in 2008, a decrease of 23.8% [14]. Although existing studies have involved the variation in the faculty teaching time, these data are not continuous for the same group. This study examines the variation in faculty members' teaching workload based on tracking data for the same group over time, making up for the insufficiency of existing studies.

3 Research method and data sources

3.1 Research method

This study adopts the case study method and selects University A in China as the case. University A is a key provincial university with a comprehensive range of disciplines, with well-established faculty. As a teaching-research university, the college excels in both teaching and scientific research, demonstrating considerable strength in both areas. Therefore, selecting University A for the case study holds a certain degree of representativeness.

3.2 Data sources

The data in this study are sourced from the statistical records of undergraduate teaching workloads for teachers obtained from the Academic Affairs Office at University A in China. The statistical tool used by University A to measure the teaching workloads of faculty is the Teaching Workload Schedule. The structure of the schedule primarily includes components such as classroom teaching, practical teaching, guidance on undergraduate research training projects, and the undergraduate tutorial system. Classroom teaching refers to the workload of faculty delivering instruction in the form of classes. Practical teaching includes experiment teaching, guidance on student internships, supervision of graduation theses, competitions and contests, as well as practical activities. Based on existing research and the feasibility of the research, we have included the guidance on undergraduate research training projects and the undergraduate tutorial system as part of the practical teaching component. Therefore, the teaching workload in this study consists of two main parts: classroom teaching workload and practical teaching workload.

The Academic Affairs Office of University A counts the faculty teaching workload once every semester. In this study, a total of 12 teaching colleges/departments in the University A were selected: College of Liberal Arts, College of Mathematical Sciences, College of Education, College of Life Sciences, College of Communication, College of Statistics, Department of Public Foreign Language,

Table 1. Characteristics of sample data.

Variables	Type	Number of samples
Gender	Male	458
	Female	399
Colleges/Departments	College of Liberal Arts	74
	College of Mathematical Sciences	82
	College of Education	70
	College of Life Sciences	73
	College of Communication	64
	College of Statistics	30
	Department of Public Foreign Language	85
	Department of Public Physical Education	46
	College of Engineering	88
	College of Physics and Engineering	142
	College of Management	62
	College of Economics	41

Department of Public Physical Education, College of Engineering, College of Physics and Engineering, College of Management and College of Economics. The database covers faculty members' teaching workload data from 2008–2009 to 2019–2020 academic years. In response to the imperfection of the earlier data and the inconsistency of the data due to the change of the statistical method, the researchers carried out a lot of data collation work such as the addition, adjustment and deletion of irrelevant information, and finally obtained 33,257 valid record of data of 857 faculty members (See Tab. 1).

4 Change characteristics of teaching workload: analysis of different faculty groups

4.1 Change characteristics of total teaching workload

The total faculty teaching workload refers to all faculty members' weekly teaching workload in the database. Faculty members at the 12 teaching colleges have a teaching workload for the year.

4.1.1 Classroom teaching workload accounts for the majority of total teaching workload

The total teaching workload includes classroom and practical teaching workload. Based on the data shown in Figure 1, the highest workload for teachers at University A was 11.55 teaching hours during the 2011–2012 academic year, while the lowest was 9.38 class hours during the 2017–2018 academic year. Overall, the workload fluctuated around 10 teaching hours. The workload for classroom teaching accounted for about 70% of the total teaching workload, with the highest value being 9.57 class hours and the lowest being 6.88 class hours. The workload for practical teaching fluctuated around 3 class hours, with the highest value being 3.61 and the lowest being 2.62, accounting for about 30% of the total teaching workload. As the workload for classroom teaching accounts for the majority of the total teaching workload, it determines the trend of changes in the total teaching workload. The workload for classroom teaching, ranging from 6.88 to 9.57 class hours, is quite close to the average weekly plan of 6.9 to 10.9 class hours for higher education college teachers in the survey conducted by the National Center for Education Statistics in the United States in 1992–1993 [18].

4.1.2 Periodic characteristics of teaching workload

In Figure 1, both classroom and practical teaching workloads vary with the year, and show continuity over a certain period, making the variation appear to be in stages. Because the classroom teaching workload is basically the same as the total teaching workload trend, here only the total teaching workload is used as the mainline to analyze the change trend of teaching workload. The total teaching workload can be roughly divided into three stages according to the trend. 2008–2009 to 2011–2012 academic year is the first stage. The teaching workload rises from 9.66 to 11.54 class hours during this stage. The second stage from 2011–2012 to 2015–2016 academic year, during which the total teaching workload shows a downward trend from 11.54 to 9.82 class hours; after 2015–2016 academic year, the variation in the total teaching workload is in a relatively stable state, fluctuating around 9.4 class hours. Compared with domestic and foreign data, the teaching workload of University A is basically consistent with that of other colleges and universities.

Data obtained from 80 universities in 50 countries indicate that most teaching loads vary from 7 to 12.5 h per week. While teaching loads vary by country, the differences are not as significant as expected [19]. It can be seen that the teaching workload of University A is also in this data range.

Changes in faculty teaching workload result from a combination of factors, such as the size of students, the number of courses, the number of faculty, the methods and

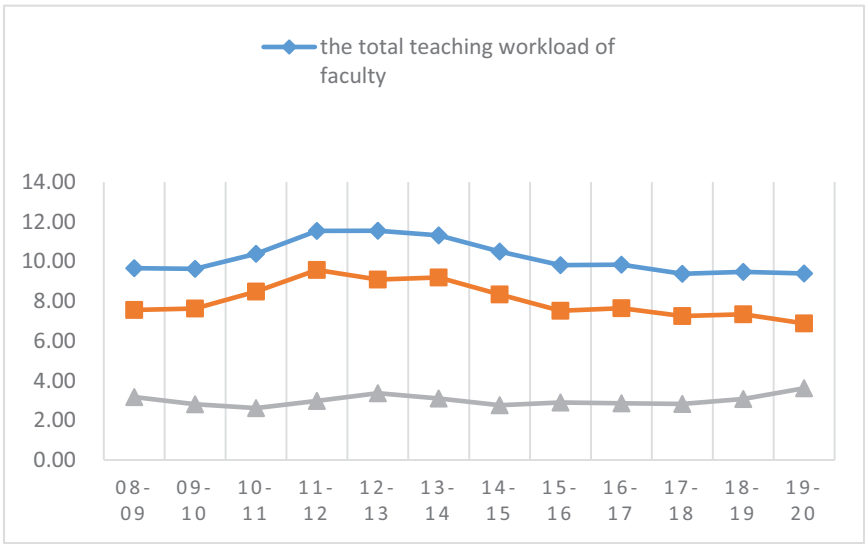

Fig. 1. Changes in total weekly teaching workload per faculty member (12 Teaching Colleges).

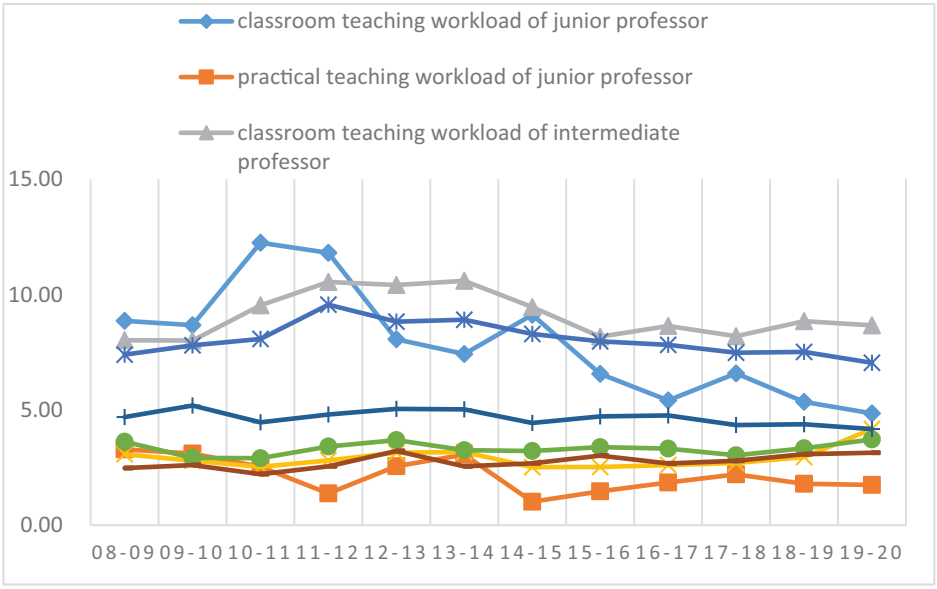

Fig. 2. Changes in weekly classroom teaching and practical workload per faculty member with different professional titles.

standards of workload statistics, etc. Although it is impossible to determine the specific reasons for the change in workload, by searching the yearbook of University A, it is found that the student-teacher ratio of University A increased year by year from 2008 to 2013, until it began to decline in 2014. In addition, in 2014, the secondary college of University A was transformed into an independent private undergraduate college. This year, independent training of freshmen was implemented. The number of students jointly trained with University A decreased year by year, and it was reduced to zero in 2016. These two sets of data coincide with the variation in classroom teaching workload. It can be inferred that the student-teacher ratio has a certain impact on the classroom teaching workload of faculty. Theoretically, the student-teacher ratio is one of the direct factors determining the teaching workload. When the number of students is the same, the number of teachers directly affects the amount of teaching workload they undertake.

4.2 Change characteristics of teaching workload by title

4.2.1 Teaching workload is mainly undertaken by faculty with intermediate and deputy senior professional titles

In Figure 2, classroom teaching workload of intermediate and deputy senior faculty is relatively high, and both are about 4 class hours higher than that of senior teachers. In practical teaching, the workload of associate professors is at the highest level overall. In general, the teaching workload of teachers with deputy senior professional titles is slightly lower than that of teachers with intermediate professional

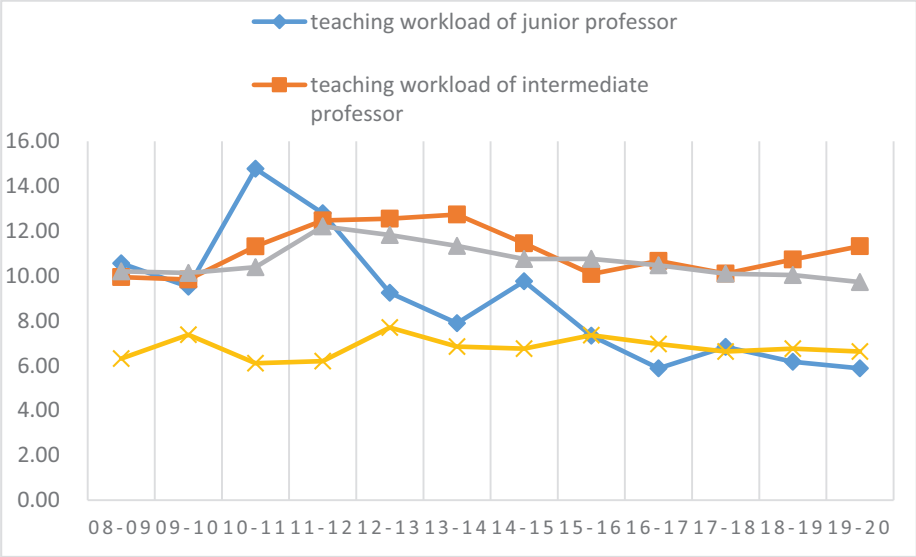

Fig. 3. Changes in weekly teaching workload per faculty member with different professional titles.

titles in Figure 3. It can be seen that intermediate and deputy senior professors mainly undertake the teaching workload in University A, which is consistent with our normal perception. Intermediate and deputy senior professors must meet the corresponding workload requirements due to the need for a promotion. The promotion policy of University A required that teaching-oriented associate professors and lecturers must meet the conditions of "the average annual classroom teaching hours should be 360 h or more since their current positions." Meanwhile, some teaching practice content is included in the evaluation indicators. Furthermore, teachers at this stage are in their young and middle age and have the physical strength and energy to support a large workload.

Classroom teaching workload of faculty with senior professional titles is mostly 4–5 class hours, which are always significantly lower than that of others (see Fig. 2). This situation is reasonable and easy to understand because professors undertake a relatively large proportion of scientific research tasks and postgraduate education.

In order to meet the development needs, the newly recruited teachers of University A in the past ten years are mainly doctoral graduates, and they are directly hired as lecturers when they join the university, so the group of teachers with junior professional titles is relatively small. During the 12 yr, the classroom teaching workload of faculty with junior professional titles was at a relatively high level before 2011–2012 academic year and then began to decline, gradually lower than that of faculty with intermediate and deputy senior professional titles. China's doctoral students without involving the teaching preparation necessary for the teaching profession, so they can be employed as university teachers as long as their academic studies meet the requirements [20]. These new teachers without professionally trained, have inadequate teaching skills are not well qualified for their teaching positions. When there is a shortage of teachers, they can only start teaching directly. After the China's higher education expansion has relatively stabilized, quality improvement has become the core of higher education development. With the gradual improvement of faculty conditions at University A, the university has started to pay attention to the teaching development of new teachers and give them appropriate support to help them teach well, such as a tutorial system and mentors for young teachers. Some colleges do not arrange courses for teachers in their first one or two years of employment and just require them to follow their mentor's lectures to learn. These findings differ from those of existing studies. Teachers with lower professional titles and less seniority spend more time in undergraduate teaching. This conclusion is inconsistent with the data in this study, which may be due to the differences in the types of the surveyed universities and data collection methods [21]. Studies of local applied universities found that the number of teaching hours for teaching assistants, lecturers and associate professors was relatively balanced and that lecturers and associate professors were the main contributors to course tasks [22]. This is similar to the conclusion of this study. A survey of economics courses at 10 Ontario universities found that the majority of assistant professors, associate professors, and full professors taught only more than half of all undergraduate courses, with the majority of their teaching being for graduate students. Lecturers, postdoctoral fellows, and honorary instructors were responsible for teaching the remaining undergraduate courses. The Higher Education Quality Council of Ontario expressed dissatisfaction with this finding [23].

4.2.2 The fluctuation of teaching workload is large among faculty with primary and intermediate titles

It can be seen from Figure 2 that the classroom teaching workload of faculty with primary professional titles fluctuates the most. It has fluctuated seven times over the twelve years, reaching a high of 12.25 class hours in 2010–2011 academic year and dropping considerably to 4.85 class hours in 2019–2020 academic year. The classroom teaching workload of teachers with intermediate

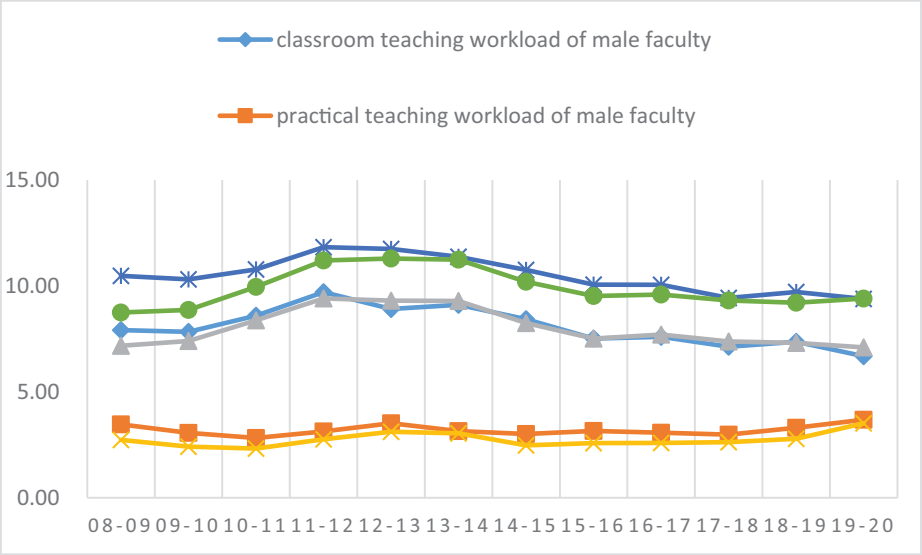

Fig. 4. Changes in weekly teaching workload per teacher with different genders.

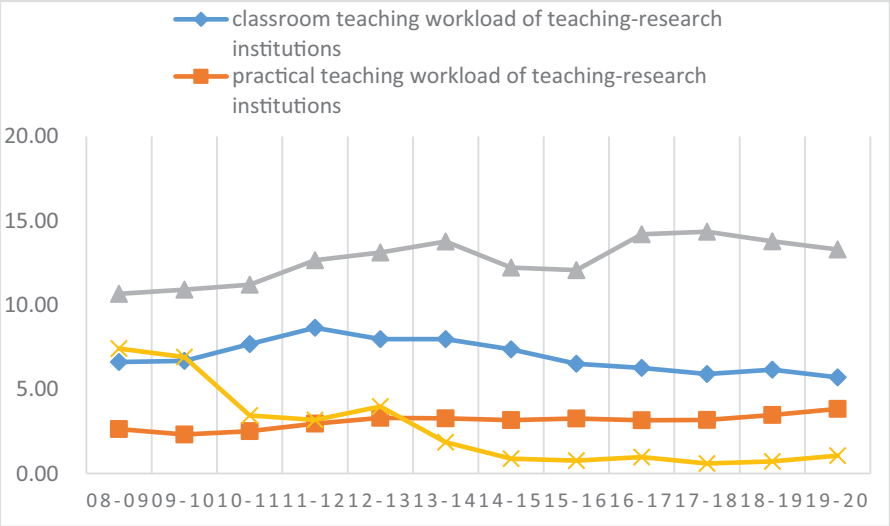

Fig. 5. Changes in weekly teaching workload per teacher in different teaching colleges.

professional titles fluctuated six times, from 10.60 class hours in 2013–2014 academic year to 7.97 class hours in 2015–2016 academic year, a drop of 2.63 class hours in three years. The classroom teaching workload of teachers with deputy senior professional titles showed an increasing trend before 2011–2012 academic year and reached a peak of 9.56 class hours in 2011–2012 academic year, after which it largely trended downward, although the decline to 7.04 class hours in 2019–2020 academic year was significant, the overall trend is moderated by the long period experienced. In the 12 yr, the maximum teaching workload of teachers with senior professional titles was 5.19 class hours, and the lowest was 4.17 h. Although there were many fluctuations during the period, the range was small. In general, the fluctuations of the classroom teaching workload of teachers with primary and intermediate professional titles are greater than those of deputy senior and senior teachers (the same situation is observed in the workload of practical teaching, which will not be repeated in this article). This suggests faculty teaching assignments are relatively variable in the early stages of their development, but gradually stabilize as they gain more years of teaching and advance in professional titles. On one hand, the constant updating of the content of tasks increases the faculty workload. For example, the preparation workload for a new course is much greater than that for a course already taught. On the other hand, the familiarity and acceptance of new tasks can also affect the quality of teaching to some extent. Therefore, relatively stable teaching tasks are of great importance to the development of faculty. This requires higher education colleges to plan well in arranging the teaching tasks of teachers, especially young faculty, focusing on their long-term development and doing overall planning.

4.3 Change characteristics of teaching workload by gender

4.3.1 Few differences between male and female faculty's teaching workload

The overall change trend of classroom teaching workload of male and female faculty is basically the same. From 2008–2009 to 2011–2012 academic year, the classroom teaching workload of male faculty was slightly higher than that of female faculty members, while the two were similar in other years. The male faculty's practical teaching workload was always slightly higher than that of female faculty in the 12 yr, and the maximum difference between the two was 0.73 class hours in 2008–2009 academic year. In general, the teaching workload of male and female faculty is equal, and there are few differences. This conclusion is consistent with the existing research, which suggests that female/male differences with respect to teaching per week are small [24], and no significant differences exist between the workloads of female and male nontenured assistant professors [19].

However, for the relationship between gender and teaching, more researchers believe that female faculty are better at teaching than male faculty, but have fewer published papers, so it can be inferred that women faculty prefer teaching rather than research [25], and spend more time teaching than male faculty [26]. This is inconsistent with the conclusion of this study that the overall teaching workload of male faculty is slightly higher than that of female faculty. This may be due to the difference in the survey methods. In this study, the overall teaching workload of male faculty is slightly higher than that of female faculty, mainly due to the difference in the workload of practical teaching. This may be because the operability and creativity of practical teaching are more in line with the characteristics of male faculty.

4.3.2 The decreasing differences between male and female faculty's teaching workload

The data show that the teaching workload of male and female faculty in 2008–2009 academic year was 10.47 class hours and 8.75 class hours respectively, a difference of 1.72 class hours. Yuker also found that the difference in working hours by male and female faculty decreased over time [19]. Blackburn et al. also noted that the differences in teaching between male and female faculty were disappearing compared to the earlier studies [24]. This may reflect the increasing pressure and self-development consciousness faced by women in the academic career of modern universities with the development of the time.

4.4 Change characteristics of teaching workload in different teaching colleges

4.4.1 In teaching-oriented colleges

Teaching-oriented colleges include the Department of Public Foreign Languages and the Department of Public Physical Education, which are mainly responsible for the teaching of public English courses and public P.E. courses across the University.

Compared with teaching-research colleges, the classroom teaching workload of teaching-oriented colleges is higher, being above 12 h since 2011–2012 academic year, reaching a maximum of 14.34 h in 2017–2018 academic year and reaching more than twice as many that in teaching-research colleges after 2016–2017 academic year, accounting for 95% of the total teaching workload. The practical teaching workload of teaching-oriented colleges is lower than that of teaching-research colleges, accounting for about 5% of the total teaching workload.

In general, the classroom teaching workload of teaching-oriented colleges accounts for an absolutely major proportion, and the overall trend has been increasing in the past 12 yr. This situation also exists in other universities. Zhai suggests that the per capita teaching workload of the Department of Physical Education in a university is the highest, with a weekly workload of nearly 20 class hours [13]. However, the average weekly workload of the College of Animal Science is only about 3.18 class hours.

As a teaching-oriented college mainly undertakes teaching functions and takes lectures as its main task, its teaching workload is significantly higher than teaching-research colleges. Meanwhile, influenced by factors such as enrollment expansion and the implementation of small-class teaching, the overall trend is increasing.

4.4.2 Teaching-research colleges

In the teaching workload structure of teaching-research colleges, classroom teaching workload accounts for about 70%, and practical teaching workload accounts for about 30%, with the gap between the two generally showing a decreasing trend over the past twelve years, partly due to the decreasing trend of classroom teaching workload and partly because of the overall upward trend of practical teaching workload.

In the mid-to-late 1990s, the phenomenon of "emphasizing scientific research over teaching" emerged in Chinese universities and colleges. In the 21st century, knowledge innovation has become the core competitiveness in the fierce international competition, and the scientific research function of the university has been further strengthened. During this period, China successively issued corresponding policies to focus on the development of some research-oriented universities, and the research orientation of the policy and its strong demonstration effect has led universities to increasingly devote more resources and energy to research. From 2007 to 2018, the ratio of faculty members with a preference for teaching to those with a preference for research went from 4:6 to 2:8, and the ratio of average weekly teaching hours to research time for faculty members went from 1:1.3 to 1:2.4 [14]. In order to achieve "upgrades" and strive for master's and doctoral program, faculty members' energy is also directed to scientific research in some local undergraduate colleges and teaching-oriented universities. Teachers are increasingly inclined to devote more energy to research, often at the cost of less investment in teaching. In University A, compared with teaching-oriented colleges, scientific research is mainly undertaken by teaching-research colleges. The increasing pressure of scientific research makes faculty members more and more reluctant to take more courses.

The increasing trend of practical teaching workload is also in line with the development trend of higher education. In 2001, the Ministry of Education issued a document pointing out that it is necessary to strengthen practical teaching further and deepen the reform of practical teaching. National Outline for Medium-and Long-Term Educational Reform and Development (2010–2020) stated that in higher education, practical teaching links should be continuously strengthened.

5 The generation logic of changes in teaching workload

5.1 Developing logic shapes the changes in faculty teaching workload

The education institution restricts the change of faculty teaching workload and thus is affected by the external forces. Some of these forces include ideological change, technological revolution, reform of political and economic systems, and development of higher education, etc. For example, in response to declining state resources, American higher education institutions often increase student/faculty ratios and teaching loads to help balance budgets [11]. The application of new science and technology also has a certain impact on the role of teaching, causing changes in teaching methods, workload and structure.

The aforementioned expansion of higher education enrollment, the establishment and transfer of secondary colleges of University A, the current environment of advocating scientific research and the emphasis on students' creative ability are in essence the reflection of the development and changes of the external environment such as social reform, higher education development, and organizational adjustment within the university. As a part of the faculty teaching environments, the development and change of this external environment shape the change of teaching workload by affecting the university.

5.2 Administrative logic drives the changes in faculty teaching workload

Policies, rules, laws, regulations, etc., as the normative and restraint mechanisms for behavior, have the functions of regulating, guiding and motivating human behavior, and can control individual actions through collective actions. The combination of these multiple variables such as control, inducement and constraint constitutes the basic administrative logic of government intervention in colleges and universities, and embeds faculty members' individual actions through colleges and universities, e.g. from the Ministry of Education's requirement that professors must teach undergraduates, to the emphasis on practical teaching, and then to the requirements of the faculty teaching workload for the appointment and promotion of professional and technical positions in University A. Behind these policies and systems from the government level to the school level, "a set of controllable procedures constructed by the causal mechanism of 'means-purpose' have created the brand of organizational statutes for faculty teaching" [27]. The quantity and structure of faculty teaching workload is not only a matter at the individual level, but to a greater extent, external policies and systems have become the incentives and forces for workload determination.

5.3 Differential logic strengthens the changes in faculty teaching workload

The logic of difference determines that the object system must be a differentiated and hierarchical system [28], and the legitimization of difference has been universally recognized, from which diversity of things arises. The complexity and peculiarity of university academic careers determine that faculty members are a diverse group. Diversity exists within groups and individuals, and the time they invest in work varies widely. This study also shows significant differences in the faculty teaching workload by gender, title and college, showing the characteristics of changes in the group itself. University faculty, as high-level talents in the academic structure, have a strong desire for self-fulfillment. At the same time, faculty members from different groups have significant differences in their self-identification due to variations in subject backgrounds, knowledge structures, academic preferences, and career planning. Consequently, these differences also contribute to significant variations in the dimension of self-fulfillment needs. These variations serve as the preliminary and foundational factors that shape the characteristics of workload fluctuations among different groups of teachers.

6 Revelations and suggestions

To clarify the change characteristics and generating logic of university teachers' teaching workload is aimed at achieving the quality goals of higher education teaching. The changes in teacher workload are influenced and driven by various factors such as development trends, administrative forces, and teacher differences. Adopting quality management systems are the strategic decision for universities, which is beneficial in terms of standardizing the management of the entire teaching process, mobilizing the enthusiasm of all faculty members to actively participate, and promoting steady improvement in teaching quality. Accordingly, in order to guide the teaching workload towards a scientific and optimized direction, it is necessary to establish the quality management systems based on the ISO 9001 standard for university teaching. This will promote the improvement of teaching quality in universities.

6.1 Following the systematic principle to govern higher education

The core of ISO 9001 is the process approach, which involves systematically defining and managing various processes according to the organizations' quality policy and strategic direction, with the aim of achieving the desired

outcomes. The university is a system composed of many processes and also functions as a component of the higher education system in a parent social system. Its development is not only influenced by the society and the parent system of higher education, but also by the adjustment of internal elements. A multi-directional and coupled relationship has been formed between its internal and external elements, which are embedded in, dependent on and promote each other [29]. The PDCA cycle, originated from the American quality guru Shewhart in 1920, has been widely applied to various aspects of ISO quality management systems. This cycle consists of four interconnected stages: P-Plan, D-Do, C-Check, and A-Act. Each completed cycle drives the process into the next cycle, creating a spiral-like upward development that gradually advances quality to higher stages [30]. Previous research has indicated the feasibility of using the PDCA cycle to standardize teaching management in higher education colleges [31]. Therefore, it is necessary to employ the PDCA cycle to systematize the university teacher's instructional management system (including workload management). Firstly, in the Plan stage, based on the demands of relevant stakeholders both internal and external to the university (such as the needs of the job market, the developmental logic of the university, the disciplinary background of teachers, and the developmental needs of students), teaching expectations and implementation plans are determined. Secondly, in the Do stage, the university's teaching management department must effectively implement and ensure the orderly execution of the teaching plans. Thirdly, in the Check stage, a comprehensive evaluation is conducted to compare the results of the current implementation with the expected objectives, aiming to identify deficiencies and shortcomings. Finally, in the Act stage, it is essential to address the issues identified in the previous stage and integrate the relevant work and experiences into the next PDCA cycle. Through this iterative process, the quality of teaching work in the university gradually improves in a step-by-step manner.

It is worth noting that the development and reform of a university are the systematic project with internal and external linkages, and that will indirectly affect the changes in the internal faculty teaching workload, which in turn will affect many aspects such as faculty development and the quality of higher education. This requires that higher education governance must follow the principle of systematization, and the preparation and adaptability of micro-level elements should be considered when carrying out macro-level changes and adjustments, and the linkage and impact on the macro level should be examined for reforms and changes at the micro-level.

6.2 Creating an organizational environment to promote teaching

An organization is composed of individuals, and it exerts college supply and mechanism constraints on individuals. It not only provides guidance on individual behavioral rules and directions but also becomes an important component that influences and constrains individual strategies and behavior patterns. The individual depends on the organization, and their development depends on the environment of the organization. According to the ISO 9000 Quality Management Systems-Fundamentals and Vocabulary, the organizational environment (context of the organization) is defined as a process that influences various factors such as the purpose, objectives, and sustainability of the organization. The organizational environment can be adjusted purposefully. Namely, it can influence human behavior through external measures and realize the control of human behavior [32]. Faculty's input in undergraduate teaching has a certain discretion. It is not only the internal manifestation of individual differences, but also the scope of independent activities and autonomous space for faculty endowed by the external organizational environment. Therefore, teaching input of faculty can be improved by creating an organizational environment. The key is to follow the leadership principle of the ISO 9001 standard, leveraging the leadership and coordination abilities of university decision-makers to establish a unified mission and direction, creating favorable conditions and environment for all teachers to engage in teaching. Furthermore, it is necessary to strengthen top-level design and provide college resources to ensure that teaching is incorporated into policies and systems related to teacher promotion, assessment, compensation, and rewards, which are closely related to teacher interests. This will stimulate, encourage, and recognize teachers' contributions to teaching. Additionally, specific regulations and systems for teaching should be formulated and improved. By implementing feedback and adjustment mechanisms such as standardization, regulation, and incentives, it is possible to enhance teachers' teaching capabilities, motivate their enthusiasm for teaching, and reinforce their awareness of teaching quality and sense of responsibilities.

6.3 Improving faculty classification management and evaluation mechanism

Universities are diverse academic organizations that are characterized by diverse organizational goals, tasks, as well as the very different groups of faculty. In the process of managing teaching quality in higher education, it is essential to adhere to the principle of engagement of people and implement teacher classification management and evaluation system that is people-centered and involves everyone. Respecting teacher differences, leveraging their strengths and clarifying their responsibilities. Through individual division of labor, it actively mobilizes the enthusiasm of teachers from different professional titles and disciplines, enhances their dedication to teaching work, and ultimately achieves the diversification of group functions to meet the diverse needs of the organization.

In fact, faculty classification management has been a concern by many national governments and universities. For example, China's Ministry of Education issued the document of the Suggestions on Comprehensively Improving the Quality of Higher Education in 2012, which clearly pointed out that the classification management and classification evaluation methods for faculty should be improved. In this regard, based on the principle of "engagement of people", universities should also strive to

follow continual improvement in ISO 9001. They should emphasize holistic process management, further refine and implement a classified management and evaluation mechanism for teachers, standardize the teaching management system, and ensure the allocation, communication, and understanding of responsibilities and authority related to teaching in higher education colleges. This will mobilize the enthusiasm of all participants, promote sustainable development among teachers, and ensure their continual growth.

7 Research limits

Firstly, due to the difficulty of data collection, only one university was selected as a study case, so the representativeness of the sample has certain limitations.

Secondly, the workloads selected for this study, which are based on faculty workload tables, have certain advantages in objectivity, but are only part of the actual teaching workload and therefore have some limitations in explaining the teaching workload of university faculty. The teaching work of faculty includes multiple contents such as lesson preparation, classroom teaching, practical teaching, and student Q&A. The teaching workload is merely an objective reflection of the amount of time teachers invest in teaching. The input of teachers' energy, emotions, and abilities in teaching is the important factor that influences the quality of education.

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