

Operational Mechanisms and Improvement Pathways of Graduate Teaching Assistant (GTA) Systems: Evidence from Shanghai Jiao Tong University and Comparative Cases from China and Overseas Universities

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Abstract: The graduate teaching assistant (GTA) system is an important component of the teaching support framework and graduate student development system of a university. Its operational quality is jointly influenced by system design, course practices, and supporting mechanisms. To investigate its operational mechanisms and optimization pathways, with GTA system at Shanghai Jiao Tong University (SJTU) taken as the research subject, practices from both domestic and international universities integrated, and questionnaire surveys and semi-structured interviews employed, the current status, characteristics, and directions for improvement of the GTA system were analyzed. Results indicate that the overall operation is currently stable, and GTAs are generally able to effectively support course instruction. However, development across different aspects remains uneven. GTA work is highly course-dependent, with faculty guidance and interactions playing a vital role in operations. Meanwhile, supporting mechanisms such as training systems, workload recognition, and evaluation incentives still require further improvement. It is recommended that when operating GTA systems, universities should strengthen the construction of whole-process governance, improve position classification and course-level onboard mechanisms, establish tiered and categorized training systems, and refine workload recognition and evaluation and feedback mechanisms to create a positive cycle of continuous participation.

Keywords: Graduate Teaching Assistant (GTA); Teaching Assistant System; Operational Mechanism; Optimization Pathway; Comparative Analysis

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1. Introduction

Graduate education is tasked with the cultivation of high-level innovative talents. Its quality is not only determined by research and innovation capabilities, but also closely related to basic aspects such as in-class teaching, training support, and educational management. It remains one of the key issues in current reforms that how the graduate training system can be

optimized and how the teaching support mechanism in universities can be improved. In this context, the graduate teaching assistant system connects teachers' teaching needs, the graduate training process, and undergraduate teaching support. By participating in in-class assistance, post-class management, and student guidance, graduate teaching assistants (GTAs) can, to a certain extent, alleviate the shortage of teaching resources in universities and also develop their comprehensive abilities in practice. This is of positive significance for improving the teaching support system and innovating the training model^[1]. However, the current teaching assistant system still faces some problems in actual operations. The job responsibilities of GTAs in some universities are not clear, and the training support and assessment evaluation mechanisms also need to be strengthened^[2]; there are also differences in the work content of GTAs, the way of teacher guidance, and institutional guarantees among different universities. These indicate that the GTA system is not a simple arrangement for teaching assistance, but involves multiple aspects such as position setting, organizational management, training support, and institutional guarantee, and requires further sorting out and optimization. Most of existing research focus on the functional positioning, ability development, and work experience of the GTA system^{[3][4]}, but systematic research on the operation of the system itself, especially the optimization pathways for improving teaching quality, is still relatively limited. Empirical analysis based on field research and comparisons between domestic and foreign universities is even rarer.

This paper takes outstanding GTAs from Shanghai Jiao Tong University (SJTU) as the research object, conducts questionnaire and interview surveys on the current operation status, and combines the experience of domestic and foreign universities to explore feasible improvement directions, providing a reference for universities to improve the management mechanism of GTAs.

2. Related Works

In recent years, researchers have conducted certain studies on the connotation and functions, the operation mechanism, and comparisons and optimizations of the GTA system.

2.1 Research on Connotation and Function

The modern GTA systems were first established in Western universities, including Harvard University in the United States^[5]. In the early 19th century, as the enrollment of undergraduate students continued to expand, university teachers faced increasingly heavy teaching burdens. To alleviate the teaching pressure on teachers, enhance the ability of graduate students to participate in teaching practice, and explore new models of graduate student funding, Harvard University, relying on donated funds from society, was the first to establish the GTA system. Existing studies have pointed out that GTAs mainly undertake auxiliary tasks for courses, including grading assignments and tests, providing experimental guidance, answering post-class questions, and assisting in teaching^[6]. Moreover, the GTA systems also pay special attention to their role in graduate student cultivation, future career development, and the teaching system of the university. Research suggests that graduate students' participation in teaching practice is conducive to the improvement of their teaching ability, communication ability, and career development ability^{[7][8]}.

With the gradual implementation of teaching reforms in universities and the innovation of graduate training models, the teaching assistant system has gradually acquired multiple functions: On one hand, the participation of postgraduate teaching assistants in course teaching support can optimize the allocation of university teaching resources and enhance teaching efficiency^{[9][10]}. On the other hand, their involvement in the teaching practice process can also promote the development of graduate knowledge application, organizational coordination, and educational practice abilities^{[11][12]}. Therefore, the GTA system is not merely a teaching assistance position; rather, it is a university institutional arrangement that combines teaching support and talent cultivation functions.

2.2 Research on Operating Mechanism

In order to make the GTA system operate more effectively, existing studies have conducted analyses from aspects such as job position setting, training support, and management evaluation. In terms of job position setting, related studies suggest that the job responsibilities of GTAs should be clearly defined based on the expected teaching input, which is also the foundation for the effective operation of the system^[13]. However, in practice, some universities have ambiguous positioning of GTA positions and significant differences between the job content and expectations, resulting in GTAs being easily burdened with a large

amount of routine work, and the functions of improving teaching quality and cultivating teaching assistants' abilities have not been fully exerted^[14]. In terms of training support, relevant studies emphasize that the GTA, as an important role for graduate students to participate in teaching, need to improve their teaching design, classroom organization, and communication and coordination skills through systematic training. Although many universities have set up certain pre-job training, some studies have shown that, the university-level training is usually too general, and departmental training is lacking or unable to meet the actual teaching needs^[15]. It is urgently necessary for each institution to make targeted improvements. In terms of management evaluation, existing studies have pointed out that teacher guidance, GTA assessment, and incentive mechanisms can help stimulate the work enthusiasm of teaching assistants and encourage them to improve their abilities. However, problems such as inconsistent assessment standards, a single evaluation subject, and insufficient incentive mechanisms may directly or indirectly affect the sustainable operation of the GTA work and the GTA system^[16].

Although the existing studies have begun to focus on multiple aspects of the operation of the GTA system, most of the researches are mainly about system description and experience summary, and there is a lack of systematic empirical analysis of the interaction relationships between different operation aspects and the actual experiences of the GTA group.

2.3 Research on Comparisons and Optimizations

In order to further enhance the participation of GTAs in improving teaching quality and efficiency, studies had been conducted in some representative universities and relevant comparisons and optimization plans were performed or proposed. For instance, Luberti, M^[17] designed a structured GTA training workflow by showing the development, implementation, and evaluation for marking consistency and feedback quality improvement within a chemical engineering course. Encouraged by the Plan-Do-Check-Act (PDCA) model, Yao, N. et al^[18] proposed an iterative, four-stage cycle model with detailed implementation to design and refine the GTA training programme each semester. Satisfactory results were shown both among GTAs and students, indicating the effectiveness of model in fostering continuous improvement and learning experiences. In terms of GTAs burdened with research tasks, research can often be prioritized over teaching by them and they receive limited formal pedagogical preparation. In this sense, Saxena, A. et al^[19] employed a content analysis of publicly available resources of GTAs to identify best practices and opportunities to reform the GTA system. Moreover, to achieve better teaching performance with GTAs, some guidelines were provided, i.e., face-to-face promotive interaction, positive interdependence, group and individual accountability, teamwork skills, and group processing^[20]. On this basis, best practices in organization, clarity of expectations, leadership, communication, and emotional intelligence were also presented.

The above works provide a foundation and ideas for the operation and optimization of the GTA system. However, there are still three shortcomings in the research. First, most of the existing studies focus on aspects such as the job setting, selection and training, management and evaluation of the teaching assistant system, and conduct analysis from a single aspect or specific element. They lack a systematic and comprehensive analysis of the interrelationships among related aspects and the overall operation. Second, the above research mostly adopts methods such as normative analysis, case studies, or experience summaries. It lacks quantitative investigation and analysis of the experiences of the teaching assistant group, especially the representative and outstanding GTA groups. Third, although the existing domestic and foreign studies have provided experiences for the optimization of the teaching assistant system, there is still a need for further comparison of the operation models of the systems in different institutional contexts and cultural backgrounds, as well as the transferable experiences. In particular, how to combine the institutional experiences of foreign universities with the operational situation of local universities and form a targeted and feasible optimization path still deserves further exploration.

Based on these observations, this paper takes outstanding GTAs of SJTU as the research object, uses questionnaire surveys and interviews to analyze the current operation status of the teaching assistant system, and combines the practical experiences of domestic and foreign universities to explore the optimization pathways of the GTA system.

3. Research Design

3.1 Overall Research Design

This study examines the operation and potential improvement of the GTA system. It focuses on how selection and matching, pre-service training, role definition, instructor guidance, workload recognition, and incentive and evaluation arrangements

shape GTAs' role perceptions, teaching engagement, self-efficacy, evaluations of the system, and willingness to continue serving. Because the GTA system involves both quantifiable perceptions and behavioural intentions, as well as contextual factors such as course type, instructor management, and prior experience, the study adopted an explanatory sequential mixed-methods design. The study proceeded in two stages. First, a questionnaire survey was used to characterise the operation of the GTA system at SJTU. Second, semi-structured interviews with GTAs from SJTU and other universities were used to explain the mechanisms underlying the quantitative findings and provide cross-university comparisons. The interview protocol was developed around dimensions that received relatively low ratings or showed meaningful relationships in the questionnaire. Interview themes were then used to interpret the quantitative results and compare them with experiences reported at other universities.

3.2 Participants and Sample Composition

The study drew on three sources of data: an SJTU questionnaire survey, interviews with SJTU GTAs, and comparative interviews with GTAs from other universities. First, the questionnaire targeted current SJTU graduate students with GTA experience who had received or been nominated for the Outstanding GTA award. A total of 101 valid responses were included in the statistical analyses. Second, purposive sampling was used to recruit seven SJTU graduate students who had served as GTAs within the previous three years. Third, five respondents with GTA experience at other domestic or international universities were interviewed. Their experience covered the Hong Kong University of Science and Technology, the Hong Kong Polytechnic University, Georgia Institute of Technology, Nanyang Technological University, Tsinghua University, and Peking University. These accounts reflected individual experience and cross-university comparisons. They were therefore treated as comparative and supplementary evidence rather than complete representations of the respective institutional systems.

3.3 Research Instruments

3.3.1 Questionnaire

The questionnaire comprised four sections: GTAs' background characteristics, information about their work, a GTA experience scale, and open-ended questions. Background characteristics included gender, school or department, degree level, year of study, disciplinary field, number of prior GTA appointments, and course type. Work-related information covered the types of duties undertaken and the most time-consuming task. Scale items were rated on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree), with higher scores indicating greater agreement. The instrument contained 37 items. Of these, 35 were used to construct eight multi-item dimensions, while Q17 and Q29 were analysed as separate single-item variables. Reliability and factorability tests yielded Cronbach's $\alpha = 0.974$ and KMO = 0.910, while Bartlett's test of sphericity was statistically significant. These results indicated high internal consistency and supported the suitability of the data for factor analysis. Cronbach's α , which assesses the internal consistency of a multi-item scale, was calculated as follows:

$$\alpha = \frac{k}{k-1} \left[1 - \frac{\sum_{j=1}^k \sigma_j^2}{\sigma_T^2} \right],$$

where k is the number of items, σ_j^2 is the variance of item j , and σ_T^2 is the variance of the total scale score. The Kaiser-Meyer-Olkin (KMO) statistic compares the relative magnitudes of simple and partial correlations among items and indicates whether a correlation matrix is suitable for factor analysis. It was calculated as follows:

$$KMO = \frac{\sum_{i \neq j} r_{ij}^2}{\sum_{i \neq j} r_{ij}^2 + \sum_{i \neq j} p_{ij}^2},$$

where r_{ij} is the simple correlation coefficient between items i and j , and p_{ij} is the partial correlation coefficient between the two items after controlling for all other items.

3.3.2 Semi-Structured Interview Protocol

The semi-structured interview protocol was developed after completion of the questionnaire analysis. Interviews with SJTU GTAs focused on task allocation, instructor guidance, workload, and incentives. The comparative interviews covered these

topics and added questions about selection and matching, pre-service training, job descriptions and authority boundaries across universities. Each interview lasted approximately 20–30 minutes. All interview materials were anonymized, and participant numbers were used in place of identifying information.

3.4 Data Processing and Analysis

Questionnaire data were analyzed in RStudio using descriptive statistics, reliability and factorability tests, and group comparisons. Differences among the three groups defined by the number of prior GTA appointments were examined using one-way analysis of variance (ANOVA). Differences between master's and doctoral students were examined using independent-samples t-tests. Statistical significance was defined as $p < 0.05$. Interview data were coded and synthesized using thematic analysis. Interviews with SJTU GTAs were used to explain and elaborate on the questionnaire findings, while interviews with participants from other universities supported cross-university comparison. The quantitative and qualitative evidence was subsequently integrated and cross-checked to strengthen the credibility of the conclusions. Because the questionnaire sample comprised high-performing GTAs, the findings should not be generalized directly to all GTAs.

4. Current Operation of GTA System at SJTU

4.1 Sample Characteristics

Data were obtained from the 2026 SJTU Outstanding GTA Questionnaire. A total of 101 valid responses were collected. The sample covered science, engineering, humanities and social sciences, life sciences, and interdisciplinary studies, and included both master's and doctoral students. The gender distribution was relatively balanced. Prior GTA appointments were classified into three groups: once, two to three times, and four or more times. Table 1 presents the sample characteristics.

As shown in Table 1, men and women accounted for 51.49% and 48.51% of the sample, respectively. Doctoral students represented 71.29% of respondents and master's students 28.71%. Engineering accounted for 45.54% of the sample, followed by humanities and social sciences (25.74%), science (15.84%), life sciences (11.88%), and interdisciplinary studies (0.99%). Respondents who had served as GTAs once, two to three times, and four or more times accounted for 31.68%, 38.61%, and 29.70% of the sample, respectively.

Table 1. Characteristics of the questionnaire sample (N = 101)

Variable	Category	n	%
Gender	Male	52	51.49
	Female	49	48.51
Degree level	Doctoral student	72	71.29
	Master's student	29	28.71
Disciplinary field	Engineering	46	45.54
	Humanities and social sciences	26	25.74
	Science	16	15.84
	Life sciences	12	11.88
	Interdisciplinary studies	1	0.99
Prior GTA appointments	Once	32	31.68
	Two to three times	39	38.61
	Four or more times	30	29.70

4.2 Current Patterns of GTA Work

The duties of a GTA are not limited to a single task but encompass a series of responsibilities, including assisting in lesson preparation, supporting classroom teaching, compiling course materials, organizing discussions, supervising laboratory classes, grading assignments, and answering students' questions. Table 2 summarizes the scope of GTA responsibilities,

highlighting the main tasks and the tasks that take the longest time. In terms of the number of people who participate in GTA roles, grading assignments and answering students' questions are the most common responsibilities. Specifically, among 101 GTAs, 78 (accounting for 77.23%) undertook these tasks, making this the highest proportion among all responsibility categories. The next most common tasks were assisting in lesson preparation (71.29%), supporting classroom teaching (70.30%), and compiling course materials (61.39%). These results indicate that the work of a GTA spans the pre-class, in-class, and post-class stages of teaching, reflecting their extensive participation in the teaching and learning process.

Furthermore, 45 GTAs (accounting for 44.55% of the total) listed "grading assignments and communicating with students" as the most time-consuming task. Therefore, this task category not only involves the largest number of GTAs but also consumes the most time, taking much longer than other tasks. This clearly shows that it has become a frequently and heavily involved important part of the current GTA role. From the perspective of improving teaching quality, this finding has two implications: On the one hand, grading assignments and communicating with students enable GTAs to promptly identify students' learning difficulties, thus constituting an important part of academic support; on the other hand, if excessive effort is devoted to grading and repetitive student consultations, it may reduce the time available for teaching design, classroom interaction, course resource development, and personalized learning support.

The development of course resources seems to impose a relatively significant time burden on GTAs. Although 62 GTAs (accounting for 61.39% of the total sample) participated in the development of course resources, 18 of them (17.82% of the total) regarded this as the task that took the longest time in their recent work, ranking second. In contrast, although 71.29% of the GTAs participated in pre-class preparations, only 14.85% considered it the most time-consuming activity. Similarly, 70.30% of the GTAs supported classroom teaching, but only 5.94% thought it was the most time-consuming task. These results indicate that although the number of participants in the development of course resources is less than that in pre-class preparations or classroom teaching, considerable time may still need to be invested in the actual implementation process. From the perspective of teaching quality, this might be a positive sign because creating PowerPoint presentations and question banks, etc., can help improve teaching quality. However, this also suggests that relevant institutions need to clearly define the responsibility scope, workload assessment standards, and evaluation methods for such tasks.

Table 2. *GTA duties and most time-consuming tasks (N = 101)*

GTA duty	Undertook duty, n	Undertook duty, %	Most time-consuming, n	Most time-consuming, %
Pre-class preparation	72	71.29	15	14.85
In-class teaching support	71	70.30	6	5.94
Organisation of after-class discussions and activities	53	52.48	5	4.95
Laboratory or practical-session guidance	45	44.55	10	9.90
Assignment grading and student consultation	78	77.23	45	44.55
Course resource development	62	61.39	18	17.82
Other	3	2.97	2	1.98

4.3 Overall Evaluation of the GTA System

Table 3 shows that GTAs have high overall evaluations of the system's operation and of their teaching participation. The mean values of all multi-item variables are above 4.48, with teaching input being the highest ($M=4.626$). The willingness to continue participation ($M=4.604$) and the overall system evaluation ($M=4.597$) also remain high, indicating that the surveyed GTAs not only actively engage in course teaching but also have a high degree of acceptance of the existing GTA system and demonstrate a strong willingness to continue participating. The mean values for clear role and responsibility, incentives and evaluation, and perceived teaching contribution are also high, indicating that current GTAs have formed a relatively positive

perception of their job responsibilities, work feedback, and their own teaching role. Cronbach's α for each multi-item scale ranges from 0.845 to 0.935, indicating good internal consistency and suggesting that the relevant variables can reliably reflect the GTAs' experience with the system and teaching.

Further analysis reveals that training support ($M=4.482$), developmental gains ($M=4.525$), and teaching self-efficacy ($M=4.531$) are relatively low compared with variables such as teaching input and clarity of role and responsibility. While the absolute differences between dimensions are not significant, this result indicates that GTAs generally have a positive evaluation of their own job performance but a relatively weaker perception of training support, skills enhancement, and personal developmental gains. In particular, the mean of "perceived substitutability of training" is 3.624, significantly lower than other variables, with a standard deviation of 0.968, indicating substantial individual differences in GTAs' judgments regarding their ability to perform their work effectively even without standardized training. Combined with the high evaluation of training support, training is not universally considered substitutable; rather, its actual effectiveness may be influenced by factors such as the GTA's existing experience, the complexity of the job tasks, and the teaching methods used. Therefore, while the current GTA system operates relatively smoothly overall, there is still room for further refinement in areas such as the alignment of training content with job requirements and support for GTA skills development.

Table 3. Descriptive statistics for variables related to the GTA system ($N = 101$)

Variable	Items	M	SD	95% CI	Cronbach's α
Training support	6	4.482	0.589	[4.366, 4.598]	0.935
Role clarity and responsibilities	5	4.584	0.490	[4.487, 4.681]	0.872
Incentives and evaluation	4	4.577	0.603	[4.458, 4.696]	0.845
Developmental gains	2	4.525	0.661	[4.394, 4.655]	0.882
Teaching engagement	5	4.626	0.467	[4.534, 4.718]	0.870
Teaching self-efficacy	5	4.531	0.501	[4.432, 4.630]	0.891
Perceived teaching contribution	5	4.576	0.514	[4.475, 4.678]	0.928
Overall system evaluation	3	4.597	0.544	[4.490, 4.705]	0.933
Perceived substitutability of training (single item)	1	3.624	0.968	[3.433, 3.815]	—
Willingness to continue serving (single item)	1	4.604	0.549	[4.496, 4.712]	—

4.4 Group Differences in Evaluations of the GTA System

Table 4 shows that none of the seven dimensions differed significantly across the three groups defined by the number of prior GTA appointments (all $p > 0.05$). GTAs with one prior appointment reported relatively high mean scores for training support, incentives and evaluation, teaching engagement, and overall system evaluation. Those with two to three appointments reported comparatively lower means on most dimensions, whereas respondents with four or more appointments reported higher scores for role clarity, developmental gains, and teaching engagement. The largest group differences were observed for training support and overall system evaluation, but neither reached statistical significance ($F = 2.186$, $p = 0.118$; $F = 2.117$, $p = 0.126$). These descriptive fluctuations did not form a stable linear pattern. More prior appointments therefore did not necessarily correspond to either more positive or more negative evaluations of the system.

Mean scores for master's and doctoral students were also similar across all seven dimensions, and none of the differences was statistically significant (all $p > 0.05$). For example, the two groups reported nearly identical levels of teaching engagement and overall system evaluation. In this sample, degree level and the number of prior GTA appointments therefore had limited power to differentiate GTAs' evaluations of the system. Course-level conditions, including task type, instructor guidance, role boundaries, and actual workload, may be more directly related to GTAs' experience. The interviews consequently focused on

these contextual mechanisms rather than treating background-group differences as the primary explanation.

Table 4. Group differences in evaluations of the GTA system

Panel A. By number of prior GTA appointments

Prior GTA appointments	n	Training support	Role clarity	Incentives and evaluation	Developmental gains	Teaching engagement	Teaching self-efficacy	Overall system evaluation
Once	32	4.616	4.600	4.648	4.557	4.686	4.544	4.676
Two to three times	39	4.355	4.487	4.524	4.444	4.554	4.467	4.463
Four or more times	30	4.561	4.720	4.625	4.700	4.687	4.600	4.658
F		2.186	2.066	0.436	1.762	1.001	0.612	2.117
p		0.118	0.132	0.648	0.177	0.371	0.544	0.126

Panel B. By degree level

Degree level	n	Training support	Role clarity	Incentives and evaluation	Developmental gains	Teaching engagement	Teaching self-efficacy	Overall system evaluation
Master's student	29	4.511	4.559	4.647	4.580	4.628	4.559	4.586
Doctoral student	72	4.494	4.606	4.572	4.546	4.638	4.519	4.589
t		0.144	-0.456	0.668	0.277	-0.108	0.367	-0.027
p		0.886	0.651	0.506	0.783	0.915	0.715	0.979

5. Evidence on GTA System Operation from Within- and Cross-University Interviews

5.1 Operational Issues Identified in Interviews with SJTU GTAs

To explain the high overall evaluations, the comparatively lower rating for training support, and the relationships among role clarity, incentives, and evaluation, thematic analysis was conducted using interviews or interview notes from seven SJTU GTAs. The questionnaire findings and interview evidence were integrated in a joint display. As shown in Table 5, participants did not describe the system as broadly dysfunctional. Instead, they indicated that its practical effectiveness was often achieved through course-level task allocation, instructor guidance, and GTAs' proactive coordination. The analysis therefore focused on five themes: differentiation of job tasks, alignment of training with job requirements, sources of competence, role governance, and incentives and continued participation.

Table 5. Joint display of questionnaire findings and themes from interviews with SJTU GTAs

Theme	Questionnaire finding	Explanation from SJTU interviews	Interpretation
Differentiation of job tasks	Duties were diverse, and assignment grading and student consultation required the most time.	Positions included administrative support, course coordination, and teaching support.	Uniform position standards do not adequately represent differences in task complexity.
Alignment of training	Training support had the lowest mean among the multi-item dimensions.	Practical content was easier to apply, whereas general content could be disconnected from job requirements.	Combine compulsory foundational training, differentiated modules, and course-specific induction.
Sources of competence	Training support was rated highly, while perceived substitutability of training had a lower mean and greater individual variation.	Prior experience, simple tasks, and instructor guidance could partly substitute for standardised training in some contexts.	Perceived substitutability of training should be interpreted as a separate single-item variable.

Theme	Questionnaire finding	Explanation from SJTU interviews	Interpretation
Role governance	Role clarity, teaching engagement, teaching self-efficacy, and willingness to continue serving were rated highly.	In practice, clarity often arose from informal communication, while written job standards remained limited.	Distinguish formal role clarity from interaction-based role clarity.
Incentives and continued participation	Incentives and evaluation, overall system evaluation, and willingness to continue serving were rated highly.	Continued participation reflected trade-offs among stipends, developmental gains, research pressure, and hidden workload.	Emphasise job differentiation, workload visibility, and developmental feedback.

5.1.1 Differences in Job Tasks Limit the Applicability of Uniform Position Standards

Survey results indicate that the work of GTAs spans various stages of the teaching process, including activities before, during, and after class. Among these responsibilities, grading assignments and providing student consultations are identified as particularly time-consuming jobs. Then interviews reveal that their actual roles can be categorized into three types, including administrative support, course coordination, and instructional support. There are significant differences in the professional skills and time investment required for different courses. Therefore, the management standards for unified GTA courses may overlook these differences. A more appropriate method is to clarify the scope of authority and design GTA work content based on the course. It can help ensure that job descriptions more accurately.

5.1.2 Training Effectiveness Depends on Alignment with Job Requirements

Although Table 3 indicates that “training support” received relatively high ratings, its mean score was the lowest among the multi-item variables. The data shows that in practical training of GTA, it will be more effectively to transform content related to course responsibilities into practical skills, but the correlation between general content and specific job tasks is weak. This means that optimizing training mechanisms should not only focus on increasing training frequency, but should be classified according to needs. In addition to standardized foundational training, the training system should provide introductory or role-specific guidance to establish a more direct connection between training content and actual job responsibilities.

5.1.3 Training Effectiveness Depends on Alignment with Job Requirements

The data shows that the overall evaluation of training support is high, but the average score of perceived training substitutability is significantly low, and there are significant individual differences. This indicates that the recognition of the value of training and the judgment of “whether one can perform the task without training” cannot be simply regarded as the same dimension. Interviews with SJTU GTAs provided further explanation: existing GTA experience, relatively simple tasks, and direct guidance from instructors can all partially substitute for standardized training in specific situations. The key to system design is not to choose between “training necessity” and “training substitutability,” but rather to allocate different levels of support based on the GTA's starting point and the difficulty of the task.

5.1.4 Training Effectiveness Depends on Alignment with Job Requirements

The questionnaire survey indicates that GTA has a relatively high overall evaluation of role responsibilities, teaching participation, teaching efficacy, and continuous participation. However, the tasks of GTA are mainly clarified through short talking with the teachers, and few written norms. Therefore, the clarity of roles can be divided into two categories: one is the formal roles at the institutional level. It could come from documents, job descriptions, and authority divisions. The other is the roles at the interaction level, which come from the specific divisions of labor and communication during the course operation. The optimization direction is not to replace the teacher's autonomy with uniform and detailed regulations, but to implement the institutional requirements in specific courses by conducting pre-job communication, task lists, scoring standards, and process coordination within the framework of setting basic boundaries.

5.1.5 Continued Participation Reflects Trade-offs among Incentives, Developmental Gains, and Time Costs

The questionnaire results showed that incentives and evaluations, overall system evaluations, and willingness to continue participation were all at high levels. Then it further indicated that a GTA's willingness to continue working was not solely determined by the stipend. It was also influenced by growth benefits, research pressure, and the implicit workload of

answering questions, preparing lessons, and grading. Therefore, simply increasing subsidies or the frequency of evaluations is insufficient to address the differences in input between different positions. Promoting job grading based on task complexity and making workload visible, and to strengthen the correlation between actual input, rewards, and personal growth through developmental feedback are very necessary.

5.2 Experiences of GTA Systems at Other Domestic and International Universities

For comparison with SJTU, five students who once served as a GTA in at universities in China and abroad were further interviewed. They once worked in the Hong Kong University of Science and Technology, Georgia Institute of Technology, The Hong Kong Polytechnic University, Tsinghua University, Peking University, and Nanyang Technological University. Instead of providing a comprehensive portrayal of the overall system at each institution, these interviews served as supplementary evidence to identify potentially useful practices.

5.2.1 Differentiated Selection and Matching for Different Types of GTA Positions

The interview results indicate that there are differences in how universities position the role of teaching assistants (GTAs) in their institutional systems, especially in terms of training requirements, appointment procedures, and the nature of teaching support provided. Some universities include teaching assistant work in their graduate training programs. For example, the Hong Kong University of Science and Technology and the Hong Kong Polytechnic University require some doctoral students to serve as teaching assistants during specific semesters. Other universities place greater emphasis on strict appointment procedures, selecting candidates through application, screening, and matching processes. Nanyang Technological University is a typical example, where the selection process includes application, material review, and interview, while also considering the applicant's academic background and relevant course experience. In addition, the allocation of teaching assistant positions usually depends on the specific characteristics of the course and the requirements of the teaching staff. For example, respondents from the Hong Kong University of Science and Technology pointed out that for certain undergraduate courses, students are assigned teaching assistants by the university or relevant departments after submitting their applications. In contrast, graduate courses or highly specialized courses are usually selected by teachers to serve as teaching assistants based on students' academic backgrounds.

5.2.2 Combining Standardized Pre-service Training, Differentiated Modules, and Course-Specific Induction

Similar to SJTU, other universities represented by the respondents also require GTA to receive pre-employment training in the first semester. Regarding training content, institutions such as the Hong Kong University of Science and Technology and the Georgia Institute of Technology have included teaching simulations or trial lectures in their GTA training programs. At the same time, Nanyang Technological University offers a combination of campus wide training (covering topics such as regulations, academic integrity, and communication) and course specific training, typically conducted with the assistance of relevant instructors, covering theoretical foundations, software usage, experimental procedures, and specific teaching requirements. In addition, although respondents generally value training on topics such as communication, teaching standards, and problem-solving, actual training needs vary depending on specific job responsibilities. For GTA responsible for attendance tracking, coordinating classroom activities, or answering non-professional questions, previous experience may be sufficient to meet basic requirements. However, for those involved in laboratory supervision, grading assignments, facilitating classroom discussions, or assuming direct teaching responsibilities, general training alone may not be sufficient to develop the professional knowledge and skills required for these tasks.

5.2.3 From Static Job Descriptions to Dynamic Task Management during Course Delivery

Interviews conducted within the university indicate that GTA often needs to communicate with faculty and staff to clarify tasks and ensure the smooth implementation of teaching activities, especially when their responsibilities are not clearly defined in standardized job descriptions. The external interview further indicates that even with a formal job description, the specific responsibilities of GTA may vary depending on the type of course, instructor arrangement, and teaching process. For example, respondents from institutions such as The Hong Kong Polytechnic University and Tsinghua University pointed out that GTA's responsibilities cover a wide range of tasks, including preparing course materials, answering student inquiries, conducting problem-solving, assisting laboratory work, organizing exams, and processing grades. Lecturers can also assign

additional tasks as needed, and when multiple GTAs are assigned to the same course, continuous coordination between them is usually required.

5.2.4 Supporting Continued Participation through Workload Visibility and Evaluation Feedback

The allowance is not the only factor of GTA's willingness to continue in this position depends. Working hours, task requirements, research pressure, and personal career development opportunities are also important. According to reports, some universities, including Nanyang Technological University, calculate allowances based on recorded working hours and verification by supervising teachers. This method allows for a more comprehensive understanding of tasks that are difficult to quantify, such as answering students' extracurricular questions, lesson preparation, and coordinating work. Other universities adopt a fixed position and standard allowance model to simplify management. However, different courses vary in terms of the number of students, grading requirements, and teaching content, which leads to the situation where assistants with the same stipend may undertake completely different workloads, thereby causing a sense of unfairness. The assessment and incentive mechanisms also differ from institution to institution. Respondents pointed out that the selection of "excellent assistants" usually takes into account student feedback, mentor evaluations, and work summaries, and the winners can receive certificates or additional stipends; however, regardless of whether they win or not, applicants may not necessarily receive specific feedback on their performance.

6. Conclusion and Implications: Optimization Pathways of GTA System

6.1 Conclusion

6.1.1 The GTA system operates relatively stably overall, but there is an imbalance in the development among different operational stages.

Based on the results of the on-campus questionnaire, GTAs generally have a relatively positive evaluation of the current teaching assistant system, indicating that the teaching assistant system at this university has a relatively stable operational foundation. Most GTAs can clearly define their tasks in actual work and complete tasks such as course assistance, student counseling, homework grading, and teaching affairs under the guidance of teachers. Although there are certain differences in the evaluation of the system among teaching assistants from different training levels and with different teaching experience, overall, there is no significant problem of system failure.

However, through on-campus interviews, it was found that the development of different aspects of the GTA system is not completely balanced. Compared to the position setup and daily task arrangement, there is still room for improvement in aspects such as training, job boundaries, workload determination, and evaluation feedback. Some GTAs' understanding of their own work mainly comes from the ad hoc explanations of the instructors and their practical experience, rather than unified system documents or standardized procedures. The current system can ensure the basic operation of teaching assistants, but its operation is to some extent highly dependent on experience and individual factors. The core task currently faced by our school's teaching assistant system is to gradually shift from ensuring basic operation to achieving comprehensive and refined operation.

6.1.2 The actual work of GTAs is highly dependent on specific courses, and the guidance from teachers serves as an important supplement.

The results of both the questionnaires and the interviews jointly indicate that the actual job content of GTAs shows significant course-specific differences. Different courses vary in terms of student size, teaching methods, and the complexity of tasks. GTAs may undertake various tasks such as in-class assistance, experimental guidance, student counseling, assignment grading, grade management, or coordination of teaching affairs. The on-campus interviews revealed that the responsibilities of GTAs are usually explained by the instructors before the start of the course or during its operation. Although some GTAs believe that this approach meets the actual needs, the clarity of their responsibilities is more based on direct communication between the teachers and the GTAs. The off-campus interviews also indicated that even though some universities have relatively clear GTA systems, the specific tasks in specific courses still need to be further determined by the teachers or the course teams.

This indicates that the GTA system has a strong dependence on courses. The unified system at the university level can

stipulate the basic duties and management requirements of GTAs, but it is difficult to cover all the specific tasks of different courses. Therefore, teacher guidance is not an accidental factor outside the operation of the system, but an important link connecting the school system with the specific course practice. Simply formulating unified and detailed job responsibilities cannot completely solve the problem of assistant duties.

6.1.3 There are significant differences in the training needs of teaching assistants. A unified training program is unable to fully meet the actual requirements of different positions.

The results of the on-campus questionnaire indicate that the majority of GTAs recognize the positive effect of training on enhancing their job competence. However, some GTAs believe that even without systematic training, they can still complete their work by relying on their existing course experience or teacher guidance. Further on-campus interviews reveal that the actual needs of GTAs for training are closely related to their existing experiences and job contents. For graduate students who are taking on GTA roles for the first time, especially those who need to provide experimental guidance, answer student questions, or conduct classroom teaching, training in areas such as communication skills, teaching norms, grading standards, and problem-solving is of great necessity. For GTAs with relevant course experience or mainly handling administrative tasks, the marginal effect of unified training is relatively limited.

The off-campus interviews further confirmed this characteristic. Although different universities generally offer various forms of GTA training, there are significant differences in the content and organization of the training. Some universities combine general training with specialized course guidance, and through practical methods such as simulation teaching and trial lectures, improve the connection between the training and actual work. Therefore, it is believed that the core issue of GTA training is not whether to increase the number of training sessions, but whether the training content can match the assistant's experience foundation and specific job tasks.

6.1.4 The continuous participation of GTAs is influenced by both the work commitment and the development gains.

The on-campus interviews revealed that the continuous participation intention of GTAs is mainly determined by the balance between the expected development benefits and the cost of work commitment. On one hand, the expansion of interpersonal networks and the improvement of teaching ability brought about by the GTA's experience constitute a positive retention intention driver. On the other hand, for graduate students with heavy research tasks and tight time resources, their fixed work rhythm and temporary additional tasks may form a strong exit pressure.

The off-campus interviews further confirmed this balancing logic and revealed the key role of institutional design in regulating this balancing relationship. Although there are differences in subsidy standards, working hour calculation, and evaluation methods among various schools, more standardized universities generally enhance the continuous participation motivation of GTAs through two mechanisms: one is to increase the visibility of implicit work volume, e.g., detailed time records, to alleviate the asymmetry in the perception of "investment - return"; the other is to improve the result feedback loop, e.g., teacher evaluation, student evaluation, and excellence selection linkage, to amplify the long-term sense of gain from development benefits. This indicates that relying solely on individual-level benefit cognition is not sufficient to maintain continuous participation; the design of closed-loop incentive mechanisms at the institutional level is also indispensable.

6.2 Insights and Suggestions

6.2.1 From single-position management to the construction of a complete operation mechanism.

The current optimization of the GTA system not only requires consideration of training content, allowance standards, etc., but also needs to focus on the entire process of the GTA work. A relatively complete system should be formed in all aspects such as recruitment, training, position arrangement, process guidance, workload determination, evaluation, feedback and incentives. First, it is necessary to further clarify the work responsibilities and relationships of the school, department, course team, and instructor in the management of GTAs. The school management mainly focuses on basic systems, general training and overall evaluation. The department arranges positions and implements classification management based on the department's discipline and course characteristics. The course team and instructors make detailed work arrangements, introduce courses and provide teaching process guidance. The division of labor among different management entities can

avoid excessive centralization of the management of GTA work in a single management entity. At the same time, it is necessary to avoid using many uniform regulations to solve problems. After clearly defining the basic system framework overall, leave flexible space for different courses, and ultimately achieve a balance between certainty and flexibility.

6.2.2 Mechanism improvement the of classified position setting and course introduction, and enhancement of the matching between positions and tasks.

The requirements for GTAs vary significantly across different courses. Based on the characteristics and work content of each course, different positions for GTAs can be distinguished, such as in-class tutoring, course support services, and answering students' daily questions, etc. Corresponding specific tasks should be assigned to each position, and the professional foundation and ability requirements for each position type should be clearly defined. When selecting GTAs, the course match degree should be considered comprehensively, taking into account the graduate students' professional specialties, relevant course experiences, etc., rather than merely requiring them to undertake GTA duties based solely on their graduate student status or the number of positions. For courses with strong professionalism and high teaching participation requirements, it is advisable to consider recommendations from teachers, student registration, or implement a two-way selection process; and to enhance the matching degree of the candidates for the position. Additionally, the pre-job introduction and task instructions at the course level should be strengthened. The instructor can propose requirements such as the course goals, work content, working hours, communication and responsibility boundaries to the GTAs before they start their positions, forming a relatively clear task list.

6.2.3 Establishment of a hierarchical and categorized training system consisting of "basic training-classification module-course introduction".

According to the different experience and job tasks of GTAs, the uniform training model should be changed and a hierarchical and categorized training system should be established. First, conduct basic pre-job training. The focus is on graduate students who are newly appointed as teaching assistants. The content includes the role positioning of GTAs, teaching norms, communication between teachers and students, academic integrity, and handling of emergencies, etc. Second, set up classified training modules based on job types. For example, for GTAs of experimental courses, strengthen training on experimental safety, equipment operation, and experimental guidance; for GTAs who undertake homework grading and answering questions, strengthen training on scoring standards, feedback methods, and communication skills; for GTAs who undertake classroom discussions or teaching tasks, add practical contents such as teaching design, classroom organization, and mock teaching. Third, strengthen pre-job introduction at the course level. The unified training mainly addresses the common issues of "how to become a qualified teaching assistant", while the teaching objectives, work processes, and task requirements of specific courses still need to be specifically explained by the course team. By combining the school's unified training with the actual needs of the courses, the training becomes more targeted and effective.

6.2.4 Mechanism improvement in determining workloads and providing feedback, and establishment of a continuous positive cycle of participation.

The visibility of the actual work commitment of GTAs should be further enhanced. The actual tasks such as answering students' questions, grading homework, preparing experiments, and organizing course materials should be included in the appropriate recording and recognition scope. For cases where the workload of different courses varies significantly, reasonable recognition can be made based on the course scale, task type, and actual input, thereby enhancing the fairness of the system. In terms of evaluation, a multi-dimensional evaluation mechanism combining teacher evaluation, student feedback, and self-reflection of GTAs should be gradually established. The evaluation results should not only be used for selecting outstanding GTAs or for statistical purposes by the management department, but also be appropriately provided to the GTAs themselves, enabling them to understand their own work performance and providing a basis for subsequent training and position arrangements. At the same time, salary incentives and developmental incentives can be combined. In addition to reasonable position allowances and selection of outstanding GTAs, training certificates, teaching experience exchanges, and growth archives can also be issued to enhance the long-term development value of GTAs' work. Through the closed loop of "workload record-multi-dimensional evaluation-result feedback-development incentive", the actual commitment of GTAs,

system recognition, and personal growth form a more stable positive cycle.

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Conflict of Interests

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