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Scholar-Teachers of Middle School Physics and the Mechanism of Their Teaching-Research Transformation

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Abstract

Through a series of questionnaires, this research mainly analyzed the differences in knowledge levels and the issue of teaching-research transformation among middle school physics teachers with different educational background. It is found that the relatively insufficient reserve of interdisciplinary knowledge is common across all academic qualification stages, and this phenomenon is particularly prominent among junior high school physics teachers. Master's degree physics teachers have the lowest teaching-research transformation ability, which is related to their strong academic utilitarianism. Moreover, master's degree physics teachers show the most significant academic utilitarianism, on the base of influenced by the professional title environment, this characteristic is more prominent among female teachers group. Based on the above findings, this research constructs a "Teaching-scholar model" for middle school physics teachers and puts forward relevant practical suggestions. It is expected to provide theoretical and practical references for enhancing the matching degree between the professional abilities of middle school physics teachers and their academic qualification levels.

Keywords: middle school physics teachers, teaching-research transformation, Master's degree

1. Introduction

In 2022, the Ministry of Education and seven other departments jointly issued the *New Era Strong Plan for Basic Education Teachers*, which proposed cultivating a group of primary and secondary school teachers and leading talents at the master' s level (Ministry of Education of the People's Republic of China and Other Seven Ministries/Commissions, 2022). In August 2024, the introduction of a policy stating that "secondary school teachers should be primarily at the postgraduate level" (Xinhua News Agency, 2024) further confirmed that teachers with postgraduate degrees generally possess greater advantages in subject knowledge, research competence, and educational attainment (Li, G. F., 2015; Hao, Q. L., Liu, Y. Y., & Hua, W. Q., 2016; Zhang, Z. S., 2015). Although the number of secondary school teachers with postgraduate degrees has increased year by year, problems such as "high qualifications but low ability" remain widespread, attributable to factors including knowledge spillover (Lee, W. S., 2018), lack of teaching experience (Zakharov, A., Tsheko, G., & Carnoy, M., 2016), and insufficient investment in teaching (Buddin, R., & Zamarro, G., 2009).

The Fifth Plenary Session of the 19th Central Committee of the Communist Party of China called for "building a high-quality education system," and the report of the 20th National Congress further emphasized "accelerating the construction of a high-quality education system" (Qu, T. H., & Gong, X. L., 2024). The shift from the "Strong Plan for Basic Education Teachers" to the "postgraduate-level as the primary qualification" policy responds to the national demand for high-quality education development. However, the facts outlined above indicate that simply increasing the proportion of secondary school teachers with postgraduate degrees is not a quick fix for accelerating the high-quality development of the teaching workforce or for serving the pursuit of high-quality education. Instead, a gradual transition is needed — from "emphasizing quantity" to "emphasizing both quantity and, more importantly, quality.”

In this context, “quality” hinges on secondary school teachers with postgraduate degrees possessing a strong “teaching-research transformation capability.” In this paper, “teaching-research transformation capability” refers to the ability to achieve mutual transformation between teaching and research. It involves not only accurately identifying research topics from teaching practice but also promptly translating research outcomes into teaching actions that yield tangible benefits. Given that physics is an experimental natural science, the teaching-research transformation capability of physics teachers requires particular scrutiny, especially when examined in light of current issues concerning academic qualifications.

2. Research Design

2.1 Research Purpose

Since there is currently lack of literature focusing on middle school physics teachers that links research and teaching, this area of study is still in the exploratory rather than verification phase — it is not yet possible to put forward specific hypotheses. Instead, by connecting it to the current context of educational background development among middle school teachers, this research focuses on addressing three key questions:

How does teaching-research transformation capacity among middle school physics teachers?

How are the scholarly attributes of middle school physics teachers manifested?

How can one become a scholar-teacher with strong teaching-research transformation capabilities?

Once the first question is clarified, the answer to the second question will have factual support. Addressing the third question amounts to providing actionable pathways related to the answer of the second question, building on its findings. These three questions are progressive and form a complete chain of questions. However, due to space constraints and given the nature of this exploratory study, this research needs to focus primarily on the first question. Its aim is to identify the key issues in teaching-research transformation among middle school physics teachers with different educational backgrounds, while avoiding redundancy.

2.2 Process and Train of Thought

Guided by systems science, this study distributed multiple sets of questionnaires to physics teachers in middle schools in Chongqing, including two categories: the main questionnaire and sub-questionnaires. The main questionnaire is a scale-based questionnaire, while the sub-questionnaires are general questionnaires. After the main questionnaires were collected, they underwent data cleaning and passed the reliability and validity tests. Subsequently, starting from the assessment of cognition in four dimensions — discipline, education, practice, and culture — this study accurately identified the educational background associated with existing issues through statistical methods such as significance calculation, effect size calculation, one-way ANOVA test, and post-hoc comparison. Due to space limitations, subsequent analysis will focus solely on teachers with this specific educational background, concentrating on investigating their teaching-research transformation issues.

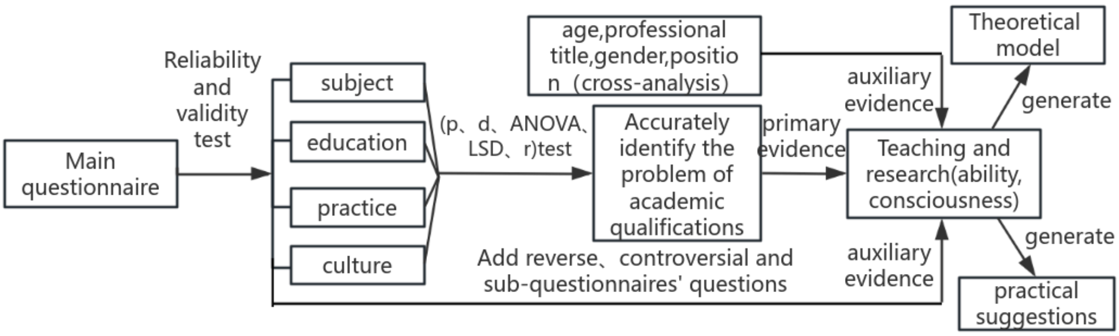

Figure 1. Based on the Statistical Analysis Framework of Systems Science

On the basis of the aforementioned statistical methods as the primary evidence, two auxiliary evidence approaches were designed to address challenges such as the inability to directly calculate the validity of sub-scales and the small sample size of teachers with doctoral degrees: First, cross-analysis incorporating variables such as age, professional title, and gender was conducted to verify potential teaching-research transformation issues among teachers with the specific educational background from multiple perspectives. Second, the controversial and reverse questions in the main questionnaire that correspond to the sub-scales, the cognitive data in the four dimensions, and the data from certain questions in the sub-questionnaires (outside the main questionnaire) can also serve as auxiliary evidence, forming a logical closed loop. The combination of primary and auxiliary evidence is analogous to “a main body with two wings,” ensuring that the final conclusions generated possess both theoretical and practical value.

2.3 Methods and Tools

This study developed the “Questionnaire on Scholar Attributes of Middle School Physics Teachers” (main questionnaire), which was distributed to physics teachers in middle schools in Chongqing via the online survey platform Wenjuanxing. A 100-point sliding scale was used instead of the traditional Likert scale in the questionnaire design, significantly improving data accuracy and granularity. Except for Questions 1 to 5, which were single-choice questions corresponding to variables such as position, educational background, professional title, gender, and age, all other questions adopted this 100-point sliding scale format. A stratified random sampling strategy was employed for teachers with undergraduate and postgraduate educational backgrounds. For postgraduate teachers (including those with master’s and doctoral degrees), simple random sampling was used. From August 1st to August 11th, a total of 500 questionnaires were collected. After excluding abnormal data — such as responses from non-middle school physics teachers, teachers under 20 years old, teachers who obtained excessively high professional titles at an unusually young age (senior titles obtained between 21 and 25 years old), and responses completed in an excessively short time (less than 30 seconds) — 347 valid questionnaires remained. Subsequently, using SPSS (Version 29.0), Questions 6 to 15 were treated as the overall scale for reliability and validity analysis. The calculated reliability coefficient was 0.87, and the KMO value was 0.89, both reaching an excellent level. And even this result was achieved under the premise that 15 were reverse-worded items and 10 were highly controversial items included as interference factors.

Then, three sub-scales were set up, namely the *Knowledge Literacy Sub-scale*, the *Competence Literacy Sub-scale*, and the *Affective-Attitudinal Sub-scale*. Among them, the Knowledge Literacy Sub-scale included Questions 6 to 9 (4 items in total), with a reliability coefficient of 0.85 and a validity coefficient of 0.82; the *Competence Literacy Sub-scale* included Questions 11 to 12 (2 items in total), with a reliability coefficient of 0.78; and the *Affective-Attitudinal Sub-scale* included Questions 13 and 14, with a reliability coefficient of 0.81. However, since the latter two sub-scales only contained 2 items each, their KMO values were consistently 0.5, making direct calculation of their validity impossible. Given the special nature of Questions 10 and 15, if they were directly included in the corresponding sub-scales, the reliability and validity would inevitably be relatively low, resulting in little reference value. Therefore, these two questions need to be placed outside each sub-scale and used as auxiliary evidence. Precisely because of the lack of validity analysis, the interpretability of these sub-scales and questions must be verified through statistical methods such as significance testing, effect size calculation, and multi-dimensional cross-analysis, as well as data from external questionnaires.

2.4 Sample Analysis

After conducting stratified random sampling, simple random sampling, and a series of rigorous data cleaning processes, among the 347 questionnaires currently collected, 198 were from teachers with postgraduate degrees and 149 from those with undergraduate degrees (before data cleaning, 250 questionnaires were collected for each group). The larger number of remaining postgraduate samples is related to the generally more careful questionnaire completion by this group. Postgraduate degrees include master’s and doctoral degrees, with 175 samples from master’s degree holders, accounting for approximately 88.3% — this basically aligns with the current situation in China where doctoral-degree-holding middle school teachers are extremely scarce, far fewer than those with master’s degrees. Due to the scarcity of doctoral samples, conclusions related to this group need to be treated with caution, and focus should be placed on the comparative study of undergraduate and master’s degree-holding teachers. There are generally large gaps between undergraduate and doctoral degree holders in various aspects. Only a few key issues regarding this phenomenon will be highlighted here, without redundant elaboration.

3. Research Findings

3.1 Interdisciplinary Limitations and Problematic Educational Background

Zhu Shuhua, Tang Zejing, and other scholars argue that teachers’ knowledge composition generally includes subject-specific knowledge, conditional knowledge, practical knowledge, and general cultural knowledge (Zhu, S. H., Tang, Z. J., & Wu, X. W., 2012). This theory not only serves as an assessment indicator for teacher qualification in China, but also forms the basis for measuring the academic knowledge level of teacher-scholars in this study. These four components correspond to Questions 6 to 9 in the questionnaire as follows:

A1. I possess substantial subject knowledge in middle school physics (beyond textbook content but still within the scope of the examination syllabus);

A2. I have rich interdisciplinary knowledge related to middle school physics, such as mathematical modeling and engineering technology;

A3. I have mastered a variety of physics-specific educational and teaching methods, such as ideal model construction and isolation analysis;

A4. I know the specific steps to apply the innovative middle school physics teaching methods I have conceived to actual teaching practice and achieve good teaching results.

Subsequently, the serial number corresponding to each proposition, the calculated average value, and the corresponding teachers' educational backgrounds were organized into Table 1. It should be noted here that since general cultural knowledge is not limited to a specific discipline, "interdisciplinarity" is used as an equivalent measure to assess teachers' general cultural knowledge.

Table 1. The Impact of Educational Background on the Cognitive Characteristics of Scholar-Teachers in Middle School Physics (Two Decimal Places Retained, Mean Value as Default)

Educational background	A1	A2	A3	A4
Undergraduate	66.62	62.09	66.49	68.38
Master	71.37	65.45	69.45	71.49
Doctor	78.70	74.96	77.96	80.48

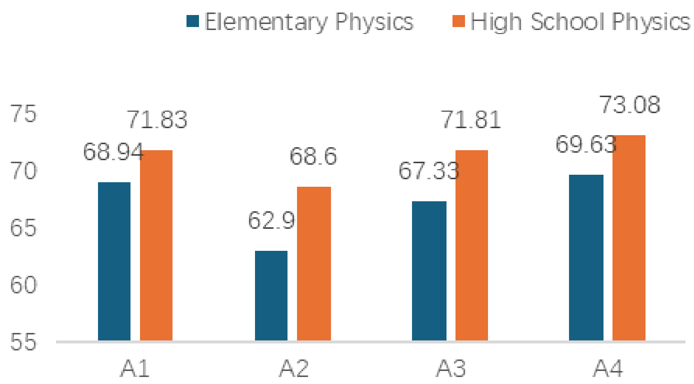

Figure 2. The Impact of Physics Teaching Stages on Various Indicators of Cognitive Characteristics

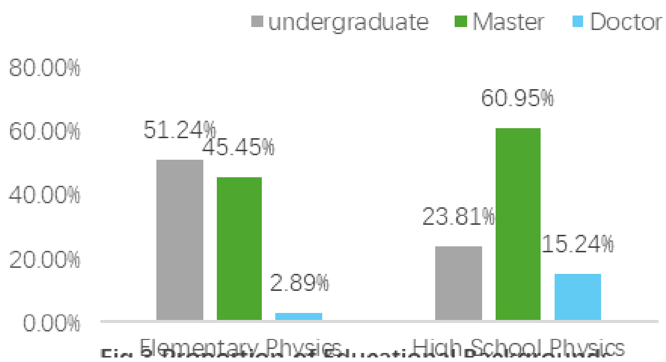

Figure 3. Proportion of Educational Backgrounds Among Jouior and Senior High School Physics Teachers

As can be seen from Table 1, the higher the educational background, the higher the mean value corresponding to each cognitive indicator. However, it is also found that the mean value of A2 across all educational backgrounds is the lowest horizontally. Furthermore, in Figure 2, the value of A2 is the lowest across different teaching stages. These findings indicate that middle school physics teachers generally lack interdisciplinary cognition. Combined with the data in Figure 3, it can be inferred that the relatively low level of interdisciplinary knowledge among junior high school physics teachers is associated with their relatively low proportion of high educational backgrounds. It will also be found from Table 2 that there are extremely significant statistical differences in each cognitive indicator among teachers with different educational backgrounds (p<0.01). As shown in Table 3, the post-hoc comparison (LSD) analysis reveals that doctoral-degree-holding teachers exhibit significant differences from teachers with other educational backgrounds across all dimensions. However, between master's and undergraduate degree-holding teachers, a significant difference is only observed in the dimension of A1 (subject knowledge). Although the mean values of master's degree-holding teachers are higher in other dimensions, the differences do not reach statistical significance.

In addition, the effect sizes for the undergraduate vs. doctoral group were all above 0.6, which is generally regarded as a "large effect" in the field of education. The effect sizes for the master's vs. doctoral group ranged from 0.4 to 0.6, which falls exactly into the category of "medium effect". For the undergraduate vs. master's group, except for A1 (subject knowledge) with an effect size ranging from 0.2 to 0.4 (classified as a "small effect"), the effect sizes of all other indicators were below 0.2. From this, it can be confirmed that although a master's degree can bring improvement in subject knowledge, its advantages in teaching methods, practical application, and interdisciplinary knowledge are not significant. Therefore, it is hypothesized here that the issue of teaching-research transformation is most prominent among teachers with a master's degree, and targeted analysis is required to verify this hypothesis.

Table 2. One-way ANOVA test results (Merely education background such an element)

Educational Background	A1	A2	A3	A4
F	6.369	5.092	5.095	6.073
p	0.002	0.007	0.007	0.003

Table 3. Significance of Various Cognitive Indicators Across Different Educational Backgrounds

Items	Undergraduate vs Master	Undergraduate vs Doctor	Master vs Doctor
A1	0.016*(0.27)	0.002**(0.68)	0.045*(0.48)
A2	0.120(0.18)	0.002**(0.73)	0.019*(0.51)
A3	0.133(0.17)	0.002**(0.70)	0.017*(0.56)
A4	0.102(0.18)	<0.001***(0.82)	0.009**(0.57)

Note: * indicates p<0.05; ** indicates p<0.01. Values in parentheses are Cohen's d values, obtained from independent samples t-tests.

3.2 Dilemmas in Teaching-Research Transformation for Teachers with a Master's Degree

3.2.1 Competency Question

The Competence Literacy dimension corresponds to Questions 10 to 12:

B1. To what extent do you believe that academic outputs (such as papers and monographs) published by middle school physics teachers reflect their teaching competence?

B2. How would you assess your own research competence? (Focused on physics teaching-research work)

B3. How would you assess your own physics teaching competence?

Following the same procedure as above, the relevant data were organized into Table 4. Additionally, the correlation coefficient between B2 and B3 was calculated, and a comparative and cross-analysis was conducted with the B1 values. Among these analyses, the examination of the correlation between B2 and B3 is particularly critical, as it serves to determine whether middle school physics teachers have achieved the parallel development of teaching and research in the process of teaching-research transformation.

Table 4. The Impact of Educational Background on the Competence Characteristics of Scholar-Teachers in Middle School Physics

Educational background	B1	B2	B3	B2, B3 correlation coefficient
Undergraduate	62.58	62.36	69.03	0.70
Master	61.72	65.98	72.52	0.57

Doctor	68.17	70.09	76.83	0.59

Table 5. Multiple Comparisons Based on LSD Test

Capability Dimension	Comparison	p	Significant or not	Cohen d
B2: Research competence	Undergraduate vs Master	0.043	Yes	0.23
	Undergraduate vs Doctor	0.011	Yes	0.56
	Master vs Doctor	0.114	No	0.37
B3: Teaching competence	Undergraduate vs Master	0.039	Yes	0.23
	Undergraduate vs Doctor	0.012	Yes	0.55
	Master vs Doctor	0.131	No	0.36

As can be seen from Table 4, the higher the educational background, the higher the scores of B2 and B3. Through ANOVA (Analysis of Variance) testing, it was found that there was no statistical significance in the responses to Question B1 among teachers with different educational backgrounds ($p>0.05$), but significant differences were observed in the responses to Questions B2 and B3 ($p<0.05$). Subsequently, LSD (Least Significant Difference) multiple comparison analysis was conducted, and the relevant information was organized into Table 5. The results showed that there were no significant differences in research competence (B2) or teaching competence (B3) between teachers with a master's degree and those with a doctoral degree. However, the effect sizes for these two dimensions (B2 and B3) between the master's and doctoral groups were both larger than those for the undergraduate vs. master's groups where significant differences were detected ($p<0.05$).

A significant factor contributing to this result is the small size of the doctoral sample (N=23). This leads to a tendency for the p-value in the master's vs. doctoral comparison to be relatively high — by contrast, an excessively large sample size would easily result in an extremely low p-value. Although the doctoral sample size in the previous analysis was the same as the current one (N=23), it still maintained relatively high statistical significance in all cognitive dimensions when compared with the master's sample. Maybe this is partially related to its higher reliability and validity. Since the effect size for the master's vs. doctoral group is relatively large, it can still be stated that there are meaningful differences between these two groups, and the magnitude of these differences is greater than that between the undergraduate vs. master's group. This is almost consistent with the earlier finding that, across all cognitive dimensions, the effect size for the master's vs. doctoral group is larger than that for the undergraduate vs. master's group.

Correlation analysis shows that the teaching-research transformation ability of master's-degree-holding middle school physics teachers (with a correlation coefficient $r=0.57$ between B1 and B2) is lower than that of undergraduate-degree-holding teachers ($r=0.70$) and doctoral-degree-holding teachers ($r=0.59$). This indicates that although master's-degree-holding teachers are superior to undergraduate-degree-holding teachers in terms of competence, their teaching-research transformation ability is relatively low. This may explain why, as mentioned earlier, master's-degree-holding teachers have no significant advantages over undergraduate-degree-holding teachers in all cognitive dimensions except subject knowledge. This may still be partially related to the tendency of "valuing theory over practice". Additionally, it is also associated with their lowest score in B1, which implies that due to their relatively weak teaching-research transformation ability, master's-degree-holding teachers may hold a more pessimistic attitude than undergraduate and doctoral-degree-holding teachers regarding whether the academic achievements obtained by teachers can effectively reflect their teaching competence.

Additionally, the B1 score of doctoral-degree-holding teachers is significantly higher than that of undergraduate-degree-holding and master's-degree-holding teachers. Combined with Table 3 mentioned earlier, the difference between doctoral-degree-holding teachers and those with other educational backgrounds — particularly in A4 (practical knowledge) — is the most significant. Furthermore, as observed in Figure 9 (discussed later), doctoral-degree-holding middle school physics teachers have more internship experience. From this, it can be roughly inferred that more internship experience fosters a stronger awareness of teaching-research transformation among doctoral-degree-holding teachers, leading them to hold a more optimistic attitude toward the aspect addressed in B1 compared to teachers with other educational backgrounds.

Table 6. The Impact of Professional Titles on the Correlation Coefficients of B2 and B3

Professional Title	Junior	intermediate	Senior

Correlation coefficient	0.69	0.49	0.64

Table 7. The Impact of Age on the Correlation Coefficients of B2 and B3

Age	21-25	26-30	31-40	41+
Correlation coefficient	0.58	0.68	0.55	0.76

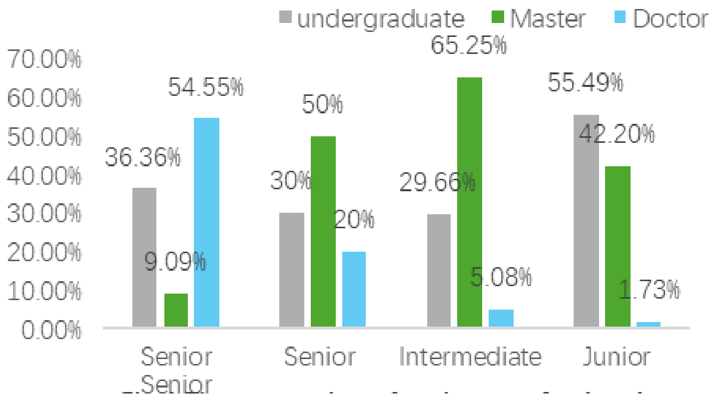

Figure 4. The Proportion of Various Professional Titles and Educational Qualifications at All Levels

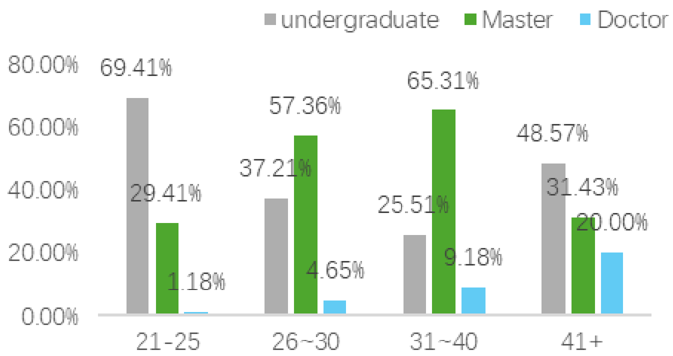

Figure 5. The Proportion of Different Age Groups and Educational Levels

Subsequently, through multi-dimensional cross-analysis of factors such as professional titles and age with the correlation coefficients of B2 and B3, it was found that master's-degree-holding middle school physics teachers not only have the lowest teaching-research transformation ability but also align with the lowest segments of the aforementioned four-dimensional correlation coefficients.

In Table 6, the correlation coefficient for teachers with intermediate professional titles is the lowest, which corresponds to the relatively highest proportion of master's-degree-holding physics teachers among those with intermediate professional titles (as shown in Figure 4).

In Table 7, the correlation coefficient for teachers aged 31–40 is the lowest, which corresponds to the relatively highest proportion of master's-degree-holding teachers in the 31–41 age group (as shown in Figure 5).

In Table 8, the correlation coefficient for male middle school physics teachers is relatively low, which corresponds to the relatively larger proportion of master's-degree-holding teachers among male teachers (as shown in Figure 6).

Also in Table 8, the correlation coefficient for senior high school physics teachers is relatively low, which corresponds to the relatively larger proportion of master's-degree-holding teachers among senior high school physics teachers (as shown in Figure 3).

In whichever dimension — professional title, age, gender, or teaching position — master's-degree-holding teachers account for the largest proportion, the overall teaching-research transformation ability of that group is the lowest. This indicates that not only do master's-degree-holding teachers have the lowest teaching-research transformation ability, but this characteristic is less influenced by the aforementioned factors than by educational background.

Table 8. The Impact of Gender and School Segments on the Correlation Coefficients of B2 and B3

	male	female	Elementary Physics	High school physics
Correlation coefficient	0.60	0.67	0.64	0.63

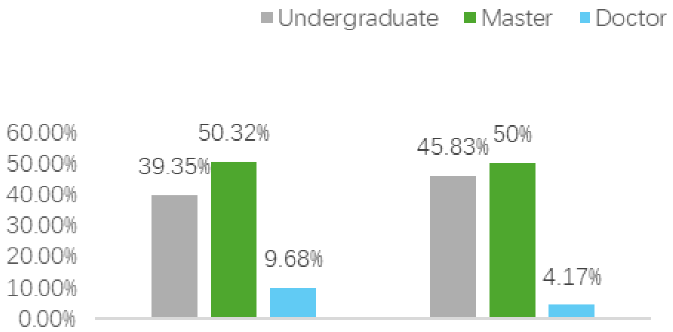

Figure 6. Proportion Distribution of Various Educational Backgrounds Across Different Genders

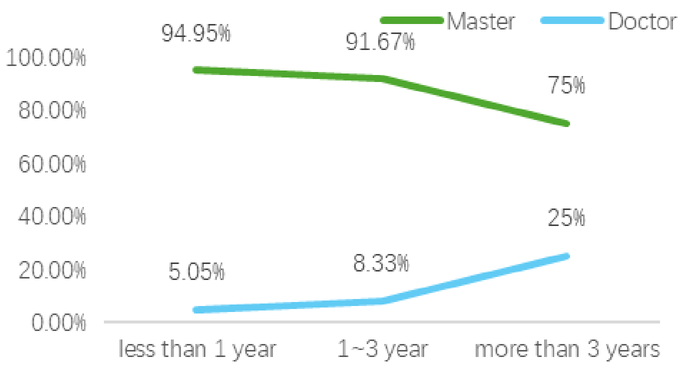

Figure 7. Comparison of Internship Experience Between Teachers with Master's and Doctoral Degrees

To understand why master's-degree-holding physics teachers have the weakest teaching-research transformation ability? As can be seen from Table 9 below, these teachers have the strongest motivation to produce academic outputs solely for the purpose of professional title evaluation. This may be closely related to the fact that master's-degree-holding teachers have the lowest correlation coefficient between B2 and B3 — even much lower than that of undergraduate-degree-holding teachers. After all, the more they overinvest in academic research for professional title evaluation (devoting more energy to publishing papers, competing for projects, and other similar tasks), the less time they have left for daily teaching. This makes it harder for their teaching skills to improve, ultimately leading to low teaching-research transformation ability.

Subsequently, a survey was conducted among 188 middle school physics teachers who hold a master's degree (among whom 7.98% also hold a doctoral degree). The relevant data were organized into Figure 7, which reveals that before formally taking up middle school physics teaching positions, the more internship experience related to physics teaching a segment has, the lower the relative proportion of master's-degree-holding teachers — and the higher the proportion of doctoral-degree-holding teachers. This may imply that doctoral-degree-holding physics teachers accumulated more relevant internship experience before and after pursuing their doctoral degrees. During their longer internship periods, they were able to convert their "research capacity" into "teaching capacity," thereby enhancing the effectiveness of their teaching-research transformation.

3.2.2 Consciousness Problem

Affective Attitudes corresponds to Questions 13 to 15:

C1. To what extent do you love the physics teaching career you are engaged in?

C2. To what extent do you enjoy conducting in-depth thinking and using specialized research methods to study issues related to physics teaching?

C3. To what extent is all the teaching-research work you do — work that requires the production of academic outputs — solely for the purpose of professional title evaluation?

Following the same procedure as above, the relevant data were organized into Table 9. The correlation coefficient between C1 and C2 was calculated to analyze its impact on teachers' teaching-research transformation ability. C3 is key to measuring teachers' awareness of teaching-research transformation, as it examines whether teachers' motivations for research and teaching are pure.

Table 9. Impact of Educational Background on Scholarly Emotional Characteristics of Middle School Physics Teachers

Educational background	C1	C2	C3	C1, C2Correlation coefficient
Undergraduate	73.32	70.25	54.3	0.62
Master	76.74	71.79	58.88	0.72
Doctor	81.43	78.09	56.04	0.72

Table 10. Statistics of Effect Sizes Among Groups Based on the LSD Test

Educational background	C1	C2	C3
Undergraduate vs Master	0.18	0.09	0.20
Undergraduate vs Doctor	0.49	0.52	0.09
Master vs Doctor	0.32	0.41	0.11

Analysis based on Table 9 shows that C1, C2, and their corresponding correlation coefficients all increase with the improvement of educational background. However, the C3 value of teachers with a master's degree is the highest, which is correlated with the lowest B1 value of master's-degree-holding teachers as presented in Table 4. This phenomenon may be attributed to strong academic utilitarianism: such teachers do not apply their achievements to solving teaching problems or demonstrating their teaching competence, but solely to pursuing professional rank promotion. For master's-degree-holding teachers, their C1 and C2 values fall between those of undergraduate-degree-holding and doctoral-degree-holding teachers, yet they are still higher than the C3 value of undergraduate-degree-holding teachers. In other words, master's-degree-holding middle school physics teachers not only demonstrate greater passion for scientific research and teaching than their undergraduate-degree-holding counterparts, but also exhibit a higher level of utilitarianism — engaging in teaching-research activities merely for the sake of professional title evaluation — compared to undergraduate-degree-holding teachers. Therefore, a hypothesis is put forward here: this so-called "passion" (which is higher than that of undergraduate-degree-holding teachers) may be more reflected as a form of extrinsic motivation rather than intrinsic motivation. To verify this point, further analysis below is required.

Through ANOVA and the associated LSD test, it was found that different educational backgrounds exhibited weak significance in shaping teachers' perceptions of C1 and C2 ($0.05 < p < 0.1$). Furthermore, the significance was even weaker for C3 ($p>0.1$). Compared with undergraduate-degree-holding teachers, doctoral-degree-holding teachers only showed statistical significance in C1 and C2 ($p < 0.05$), while no significant differences were observed between other groups. In particular, there were no significant differences between any groups in terms of motivation for professional title evaluation.

To further uncover underlying issues, independent samples t-test was still employed here, and the relevant effect size calculations were organized into Table 10. It can be observed that the effect size between undergraduate and master's-degree-holding groups was the lowest for both C1 and C2, lower than that between master's and doctoral-degree-holding groups. This indicates that from the undergraduate to the master's level, there was no practically significant improvement in middle school physics teachers' passion for teaching and research. With a value close to 0.2, C1 may barely be interpretable (suggesting a marginal improvement in teaching enthusiasm); however, C2 was less than 0.1, meaning that the research enthusiasm of master's-degree-holding middle school physics teachers had barely seen any practical improvement compared to their undergraduate counterparts. This finding corresponds to the minimal difference in the mean value of C2 between undergraduate and master's-degree-holding teachers shown in Table 9.

In contrast, C3 had the largest effect size (d = 0.2, consistent across all comparison groups), indicating that from the undergraduate to the master's level, teachers' academic utilitarianism not only increased but also this increase held the most practical significance. Therefore, the above analysis further confirms that the strong extrinsic motivation of master's-degree-holding teachers in research would relatively weaken their intrinsic motivation, which has become a key psychological factor contributing to their low teaching-research transformation capacity. Nevertheless, d = 0.2 remains relatively low. Since the issue involves professional title evaluation, greater consideration must be given to the influence of the professional title environment in their respective institutions.

Table 11. Mean Scores of C3 Across Various Professional Title Levels

Professional title	Junior	intermediate	Senior
Average score	56.62	56.72	55.65

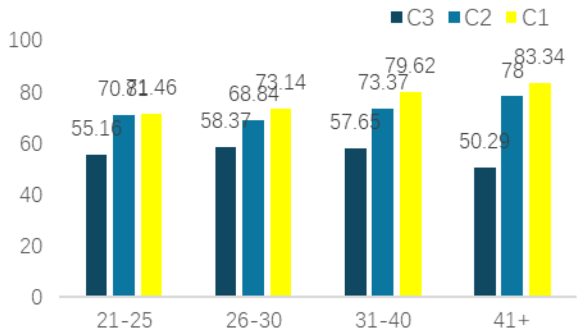

Figure 8. Emotional Attitude Performance of Teachers Across Age Groups

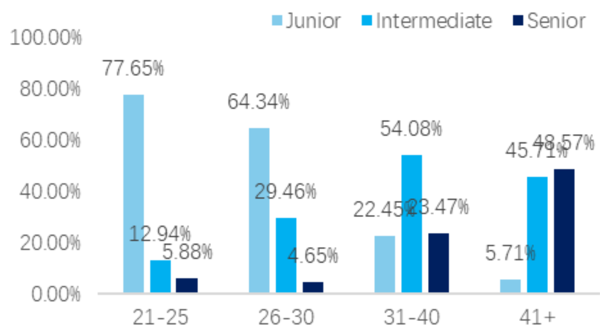

Figure 9. Proportion of Teachers' Professional Titles Across Age Groups

As shown in Table 11, physics teachers with intermediate professional titles have the highest C3 values, while those with senior professional titles have relatively lower C3 values than the previous two groups. It can be generally observed that teachers at or around the intermediate professional title level, who are in a period of rapid career development, have the strongest motivation to produce results through teaching-research activities and even achieve professional rank promotion. In contrast, C3 values are the lowest among teachers with senior professional titles. This largely indicates that after achieving the ultimate goal of professional title evaluation, many teachers experience a significant decline in motivation in this regard. Two scenarios may arise: first, they suffer from career burnout, neglect teaching-research work, and see a deterioration in their sense of innovation and thinking abilities; second, they become more rational, rely less on achievements to demonstrate their teaching competence, and adopt a more unadulterated attitude towards their work.

Combined with the findings in Figure 7, it is noted that C1 values are higher than C2 values across all age groups, indicating that, overall, teachers' passion for teaching is greater than that for research itself. Furthermore, both C1 and C2 values increase slowly with age, reaching the highest level among teachers above 41 years old. Based on this, it can be roughly determined that the second scenario (becoming more rational and adopting a purer attitude) is more common.

An additional survey was conducted among 302 middle school physics teachers, revealing that 49.34% of the teachers reported their institutions had introduced requirements for paper publication starting from the application for intermediate professional titles. In contrast, the proportion was only 13.25% for those starting from the primary title application, and 37.09% for senior associate title applications. Obviously, the proportion is the highest for the intermediate title level — which largely explains why middle school physics teachers with intermediate professional titles generally have the strongest academic utilitarian motivation.

Findings from Figure 10 further show that C3 values are nearly the highest among teachers aged 31–40. Although slightly lower than those aged 26–30, there is little difference in C3 between the two age groups. Furthermore, coincidentally, the proportions of teachers with intermediate professional titles and master's degrees are both relatively the highest in the 31–40 age group (see Figures 9 and 5). This means that, on the premise that middle school physics teachers with master's degrees generally have strong academic utilitarian motivation, if we investigate the potential issues regarding the transformability of achievements hidden within this group, screening based on the two variables (the 31–40 age group and intermediate professional titles) is likely to reveal more cases where achievements are divorced from teaching practice.

Additionally, this study also examined gender-based differences in academic utilitarianism among middle school physics teachers. The measurement results showed that the mean C3 values for male and female teachers were 54.63 and 58.13, respectively. For male teachers, C1 (teaching enthusiasm) stood at 78.37 and C2 (research enthusiasm) at 72.94 — both higher than the corresponding values for female teachers, which were 73.34 (C1) and 70.39 (C2). This indicates that male middle school physics teachers generally have greater interest in teaching and research than their female counterparts. Female teachers exhibit less intrinsic motivation, which largely corresponds to their relatively higher level of academic utilitarian motivation (evidenced by C3 = 58.13 > 54.63).

4. Research Implications

Firstly, this study preliminarily defined the concept of teaching-research transformation. Then, drawing on research on the "teacher-scholar" model by scholars such as Tang Bowen and Ernest Boyer, the issue of academic drift was identified. While this phenomenon primarily occurs in higher education, its influence extends to middle schools through teacher education programs. Based on this, a definition of "academic alienation" was proposed herein, emphasizing that the problem of teaching-research transformation in middle schools requires greater attention. Through a series of surveys, it was found that middle school physics teachers with higher educational backgrounds demonstrate stronger performance in four dimensions of knowledge — subject-specific knowledge, pedagogical knowledge, practical knowledge, and interdisciplinary knowledge — along with enhanced teaching and research capabilities, and a deeper passion for teaching and research. This indicates that higher educational backgrounds bring positive impacts to teachers in various aspects; yet, there are potential risks of "academic alienation."

Beyond the relatively weak interdisciplinary knowledge among middle school physics teachers (especially those in junior high schools), which is a common issue across all educational backgrounds, the low teaching-research transformation capacity and strong academic utilitarian motivation of middle school physics teachers are primarily observed in the master's degree group. In response to the above findings, and building on the preliminary definition of teaching-research transformation, a scholar model was constructed herein, and relevant suggestions were put forward.

4.1 Model Construction

Based on the theoretical model in Figure 10, individuals should develop their personal literacy in teaching-research transformation on the basis of the coordinated development of disciplinary, teaching, practical, and cultural cognition. They need to establish and enhance the teaching-research transformation capacity guided by the principle of "promoting teaching through research and defining research by teaching," as well as the teaching-research transformation awareness rooted in the concept of "taking teaching as the foundation and research as the means" — thereby combating academic alienation with the "integration of teaching and research."

On a personal level, teaching-research transformation serves to strengthen one's dual attributes as a teacher and a scholar, and embodies the scientific outlook on development that emphasizes the integration of teaching and research. Specifically, the principles of “defining research by teaching” and “taking research as the means” demonstrate a scholarly attitude, while “promoting teaching through research” and “taking teaching as the foundation” reflect the responsibility of nurturing students. When these two attributes (teacher and scholar) are developed to the utmost, one will possess the qualities of both an educator and a scientist: not only can they uphold the purity of truth like a scientist, but they can also fulfill the mission of “fostering virtue and nurturing people” like an educator — setting an example for students as both excellent scientist and outstanding educators.

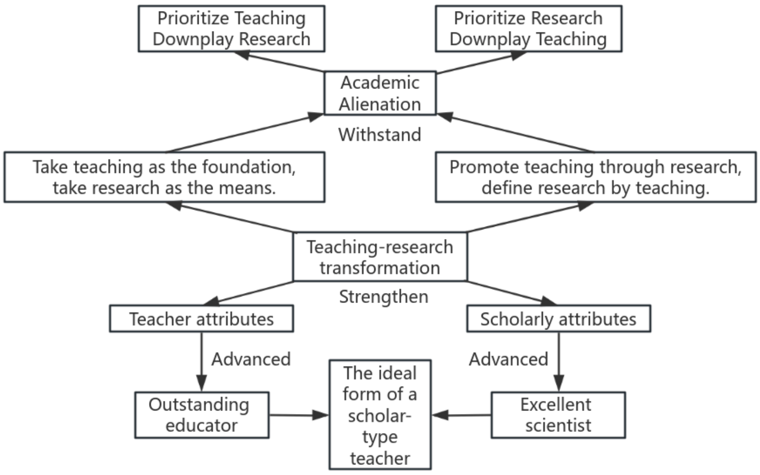

Figure 10. Growth Model of Middle School Physics Scholar-Teachers Based on Teaching-Research Transformation

Rooted in experiments, physics is the crystallization of wisdom forged through the painstaking efforts of countless physicists over centuries. This fact determines the necessity of integrating the scientist spirit into middle school physics teaching, embodying the scholarly attributes that physics teachers ought to possess. For instance, Li Xuan et al. argue that integrating the scientist spirit into middle school physics education is an essential practice to fulfill the fundamental task of “fostering virtue and nurturing people” (Li, X., Qiu, S. Q., Yang, D. C., et al., 2025).

Middle school students are in the critical stage of developing their outlook on life, values, and worldview. Compared with the scientist spirit, the integration of the educator spirit is more characterized by a tacit nature. This requires transcending the paradigms of scientism and cognitivism on this basis, exploring the humanistic values of the physics discipline, and highlighting the educator’s essence that emphasizes the parallel development of science and humanity. For example, Li Wei et al. endow the scientist spirit with greater educational significance, believing that in addition to the rationality of seeking truth from facts, the scientist spirit should also encompass the humanistic qualities of patriotism and dedication, as well as the social attributes of collaboration and educational commitment (Li, W., Guo, X. Y., & Xing, H. J., 2023).

The organic integration of these two spirits represents the conceptual sublimation of teaching-research transformation. Therefore, only under the guidance of scholar-teachers can physics play its role in shaping souls and nurturing people; only through the integration of teaching and research can the separation of the two be avoided; and only by implementing teaching-research transformation can middle school physics teachers achieve growth as scholar-teachers.

4.2 Practical Suggestions

First, for the pre-service stage: Regarding Master of Education students in universities, efforts should be made to strengthen collaboration between industry mentors (in-service middle school teachers) and on-campus supervisors, guiding pre-service teachers to formulate clear and rational personal development plans. This ensures that future middle school physics teachers will possess a high level of teaching-research transformation capacity, as well as the competence and awareness to uphold the principles of “Promote teaching through research, define research by teaching” and “Take teaching as the foundation, take research as the means”. For Master of Science students intending to teach middle school physics in the future, universities should appropriately lower the requirements for research outputs required for graduation. These students should be allowed and supported to participate in middle school physics teaching internships to make up for shortcomings in professional teaching skills.

Second, for the teacher recruitment stage: The principle of "merit-based appointment" should be adhered to, and the malpractice of "overemphasizing five rigid criteria" (e.g., academic degree, papers, titles, projects, and awards) should be eliminated. For institutions that need to recruit teachers with postgraduate degrees, priority should be given to assessing candidates' awareness and competence in teaching-research transformation. Particularly in structured interviews, the multi-dimensional evaluation of postgraduate-educated candidates' teaching and research abilities should be scientific and balanced, avoiding overemphasis on either pure teaching or pure research — this determines whether their teaching-research transformation capacity can be truly reflected.

The scale developed in this study is suitable for investigating the overall teaching-research transformation status of teachers with different educational backgrounds at a macro level. To assess an individual candidate's actual teaching-research transformation capacity during recruitment, a simplified version of this scale can be referenced, with indicators refined as needed across various dimensions. This allows recruiters to roughly determine through a single assessment form: Does the candidate only teach rigidly according to established routines? Or does the candidate only engage in research in isolation, pursuing "titles" (e.g., research projects and programs) while ignoring students' actual developmental needs?

Third, for the in-service stage: Special attention should be paid to establishing and improving a heterogeneous evaluation mechanism, and giving full play to the incentive and promotional functions of professional title evaluation. Based on the findings above, specific suggestions are as follows: For undergraduate-educated physics teachers: Appropriately increase requirements for teaching-research tasks (not for publicly published outputs). For master's-educated physics teachers: Timely and moderately increase the weight of teaching performance in evaluations to prevent them from using their research advantages to squeeze out undergraduate-educated teachers' promotion opportunities and ensure their research outputs do not deviate from practical teaching needs. Add "guiding undergraduate-educated teachers in research" as a task indicator to ensure a balance between competition and cooperation. For teaching performance evaluation: Increase the weight of interdisciplinary lesson plan development, encourage teachers to conduct in-depth teaching, and improve the effectiveness of physics curriculum development and implementation.

In summary, to facilitate the growth of middle school physics teachers into scholar-teachers and prevent advanced academic degrees from becoming "empty credentials," three key measures are essential: Strengthen collaboration between universities and middle schools in cultivating pre-service physics teachers; Ensure merit-based teacher recruitment, avoiding over-reliance on academic degrees, titles, and other superficial criteria; After teachers are employed, their institutions should adopt personalized promotion policies based on different educational backgrounds and foster a harmonious environment that balances competition and cooperation.

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