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# Evaluating Teaching and Research Capabilities of Higher Vocational Colleges in Hainan

Xia Liu[1,2*], Yuli Wang[3], Kebu Wang[4] , Shanshan Li[5], Hongfeng Zhang[6*]

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**ABSTRACT**

**Purpose.** This study investigates the teaching and research capabilities of 14 higher vocational colleges in Hainan from 2020 to 2022, motivated by their critical role in supporting local economic development and industry upgrading, particularly under the Hainan Free Trade Port initiative. **Methodology.** Data collection focused on five key dimensions: academic papers, research projects, patents, teaching competitions, and teaching achievement awards. The study employed the entropy value method for a comprehensive evaluation of these capabilities. **Findings.** Results indicate that high-quality academic outputs are concentrated in institutions with double-high construction and distinctive professional characteristics. Research projects align closely with provincial priorities, emphasizing regional development and industrial needs. Inventions and utility model patents dominate patent portfolios, reflecting a focus on practical innovation. Teaching competitions and achievement awards highlight the involvement of professional leaders and frontline educators in enhancing teaching quality. **Implications for Research and Practice.** This research recommends fostering paradigm shifts in teaching and research, building high-quality teams, implementing a sustainable evaluation system, and adopting differentiated management strategies for institutions. However, limitations include reliance on publicly available data and a lack of qualitative insights, suggesting avenues for future research. These findings provide actionable insights for policymakers and institutional administrators aiming to enhance vocational education's impact.

[1] Faculty of Humanities and Social Sciences, Macao Polytechnic University; Macao 999078, China
[2] Sanya Aviation and Tourism College; Sanya 572000, China
ORCID: https://orcid.org/0000-0001-7190-5032 , Email: p2315160@mpu.edu.mo
[3] School of Business, Pusan National University; Busan 46241, Republic of Korea
ORCID: https://orcid.org/0009-0009-8962-6897 , Email: Wangyuli9585@126.com
[4] Sanya Aviation and Tourism College; Sanya 572000, China
ORCID: https://orcid.org/0009-0005-6008-1812 , Email: 97612175@qq.com
[5] Sanya Aviation and Tourism College; Sanya 572000, China
ORCID: https://orcid.org/0009-0001-6340-418X , Email: 515157293@qq.com
[6] Faculty of Humanities and Social Sciences, Macao Polytechnic University; Macao 999078, China
ORCID: https://orcid.org/0000-0002-3485-3189 , Email: hfengzhang@mpu.edu.mo
*Correspondence: hfengzhang@mpu.edu.mo

## Introduction

As an integral part of the national education system, vocational education plays an irreplaceable role in driving economic and social development while meeting labor market demands. The National Program for the Implementation of Vocational Education Reform explicitly states that vocational education holds equal importance to general education. The Outline of the Fourteenth Five-Year Plan for the National Economic and Social Development of the People's Republic of China and the Vision for 2035 further emphasizes enhancing the adaptability of vocational and technical education. It advocates for implementing a plan to improve the quality of modern vocational education, building high-level vocational colleges, and cultivating innovative, application-oriented, and skilled talents. The report of the 20th CPC National Congress underscores the importance of integrating vocational education with industries, science, and education, optimizing its positioning, and enhancing its service capabilities.

In modern vocational institutions, talent cultivation, scientific research, social services, and cultural inheritance and innovation constitute the four primary functions. Among these, talent cultivation serves as the core function, which synergistically interacts with the others. The high-quality development of vocational education is inseparable from strong research support, as the quality of research outcomes directly impacts talent cultivation, social service capacity, and cultural innovation. During the "14th Five-Year Plan" period for vocational education, achieving quality improvement and adaptability goals necessitates the deep integration of teaching and research to provide intellectual support for high-quality development (Guo & Wang, 2020)

However, current research in vocational education predominantly focuses on teaching reform and skill development, with limited studies systematically evaluating teaching and research capabilities in vocational institutions. As China's only free trade port, Hainan's vocational colleges bear the critical responsibility of supporting local economic growth and driving industrial upgrading. Therefore, an in-depth analysis of the teaching and research capabilities of vocational colleges in Hainan is crucial not only for optimizing resource allocation but also for providing theoretical and practical support for the high-quality development of vocational education.

This study examines 14 higher vocational colleges in Hainan, analyzing their teaching and research capabilities across five dimensions: academic papers, research projects, patents, teaching competitions, and teaching achievement awards. Using the entropy method, an evaluation system is constructed to systematically assess the current state of these capabilities. The study aims to identify the characteristics, strengths, and challenges of teaching and research activities in Hainan's vocational colleges, offering recommendations for policymakers and institutional administrators while providing a reference for further research in vocational education.

## Literature review

In 1990, Ernest Boyer introduced the concept of 'teaching and learning' in the Academic Report, emphasizing the complementary nature of these two activities. According to Professor. Pan Maoyuan, an expert in higher education research in China, applied technology-based colleges and higher vocational colleges should integrate educational and teaching activities with scientific research tasks. Existing research has shown a lack of investigation into the assessment of teaching and research capacity in higher vocational colleges and universities, particularly in the context of performance management (Han & Xu, 2019; Horta & Shen, 2019; Zhang et al., 2017). Additionally, the phenomenon of 'two skins' in research and teaching has been observed in these institutions (Liu, 2019), which has raised concerns within the academic community. Further research is needed in this area.

### *Research on the pedagogical development of teachers.*

Scholars in undergraduate and higher vocational colleges have been exploring the teacher development index. Liu (2019) synthesized teaching development theories with practical implementations in Chinese vocational colleges and universities, outlining a '6+1' indicator system encompassing teacher teams, teaching reform, material projects, theses, achievement awards, training bases, and teaching competitions. Liu et al. (2024) provided an overview of the characteristics of this index in general undergraduate institutions. H. Zhang et al. (2023) further developed and analyzed this index, establishing a theoretical model for faculty teaching development in undergraduate colleges, drawing from seven key dimensions. L.-h. Zhang et al. (2023) and Wang (2022) analyzed the characteristics of teacher development in different types of undergraduate and vocational colleges in China, respectively, using the Teaching Development Index. Wang (2022) particularly constructed a scientific teacher development index evaluation system for vocational colleges, which includes 5 primary indicators, 15 secondary indicators, and 35 tertiary indicators. The Delphi method and hierarchical analysis were employed in the construction process.

The Teaching Achievement Award, an important recognition of teachers' teaching research, has gained increased attention from the academic community in recent years. This has led vocational colleges and universities to reassess their value and elevate their significance in teacher appraisals (Wang et al., 2020; Zhang et al., 2022). Concurrently, the Teachers' Teaching Competition has emerged as a key event for assessing the teaching skills of teachers in higher vocational colleges. It is seen as a comprehensive means to enhance teachers' vocational, professional, and pedagogical skills, and foster the development of dual-teacher and teaching innovation teams (Guo & Wang, 2020; Wang & Feng, 2022; Zhang et al., 2022).

### *Research on evaluation studies*

Teacher performance evaluation, which includes assessments of teaching ability and scientific research level, serves as the basis for promotions and bonuses Zhao et al. (2022). It's crucial to maintain objectivity in this process and avoid subjective evaluations.

University research evaluation, which focuses on the evaluation process, plays a guiding role in teachers' professional development and aims to promote their growth, benefiting both the school and the individual teacher (Bullis, 2014; Göksoy, 2014). In the U.S., research evaluation is used to understand and assess each teacher's research, focusing on their future potential and development direction. The fundamental purpose is to tailor professional development proposals for teachers to meet their reality (Brown et al., 2015).

When evaluating the scientific research and innovation capacity of universities in developed countries, the focus is on objective scales and criteria, including the quantity and quality of scientific research input and output, the degree of influence on others or advanced knowledge, and the social benefits of the results (Geuna & Martin, 2003). The evaluation criteria for scientific research are complex due to the specificity of various disciplines and the differences in research results among different research types. For instance, the evaluation of social science research quality can be categorized into internal and external criteria. Internal quality evaluation pertains to the assessment of the value of scientific research results by academic peers, while external quality evaluation pertains to the contribution of scientific research results to society (Mazlish, 1982).

Given the variations in development paradigms and talent training models across different disciplines, it's necessary to establish distinct evaluation criteria for research performance (Boyd et al., 2005). Furthermore, considering the crucial role of transferring and utilizing scientific research findings, it's necessary to screen and integrate evaluation criteria across various disciplines (Taylor & Tyler, 2012). Chan (2015) proposes a comparative evaluation of colleges, universities, and teachers based on set research evaluation standards. Despite differences in research evaluation standards among universities, the academic value of research results remains the core of these standards (Merton, 1973). American colleges and universities also consider the economic benefits of teachers' scientific research achievements and use economic value as a key standard for scientific research evaluation (Geuna & Martin, 2003).

In the realm of quantitative evaluation methods, the focus has primarily been on evaluating teachers' research performance, with scholars like Haapakorpi (2017) and Kozleski and Handy (2017) leading the way. American studies like (Charnes et al., 1981; Cooper et al., 2007) have proposed the data envelopment analysis method, a quantitative analysis method based on linear programming for evaluating comparable input and output indicators, De Witte and Rogge (2010) further modified this non-parametric data envelopment analysis model, and constructed a new multidimensional research input and output evaluation method. Other methods such as hierarchical analysis (Saaty, 2001), the bibliometric method (Pritchard, 1969), and the H-index method (Hirsch, 2007) have also been referenced. Various methods including the composite index method (Green et al., 1992) and the productivity evaluation index method (Rosen, 1979) have been used in university research evaluation activities, enriching the ways of research evaluation and promoting university research and teachers' professional development.

Research evaluation in undergraduate institutions has also been extensively studied. Han (2014) developed distinct index systems for various disciplines and assigned different

index weights to different types of teachers. Bao et al. (2017) proposed a set of indicators based on scientific research process data, covering various aspects of teaching and research. Hu et al. (2017) developed a diverse quantitative system for evaluating scientific research performance in colleges and universities, using the 'Changchun University Teachers' Scientific Research Confirmation Criteria' as a model. Xu (2024) proposed objective indicators for assessing scientific research performance, including high-level academic papers, scientific research projects, competitive project funding, and patents authorized at the provincial and ministerial levels.

In recent years, Chinese higher vocational colleges and universities have made several attempts in research evaluation. A recent study by Zhou et al. (2024) conducted data envelopment analysis of scientific research performance for higher vocational colleges. Wang and Feng (2022) applied the Analytic Hierarchy Process (AHP) and expert scoring to develop an evaluation index system for higher vocational teachers' research competence. Liu et al. (2025) constructed research assessment systems and conducted empirical research on the research competitiveness analysis of the evaluation of the effect of international cooperation on the cultivation of talents in vocational colleges under the construction of "double-high. Recent studies have utilized biographical analysis to enhance the evaluation of the academic community. Studies like (d'Hooghe et al., 2018; L.-h. Zhang et al., 2023; Zhou et al., 2024) have applied this method to authors in core journals, noting changes in their titles and qualifications over time. While much research has assessed higher education teachers' scientific research abilities, this study seeks to establish a measurable, unbiased evaluation system for academic papers, projects, patents, and teaching awards, specifically designed for China's higher vocational colleges. Empirical studies in Hainan's institutions was conducted to assess their educational research capacity, with a focus on integrating teaching and research evaluation systems and recognizing teaching achievements (Liu & Gao, 2021; Liu, 2020; Ou et al., 2024; Yuan et al., 2023)

## Methodology

### *Data sources and research sample*

The development of teaching and research in Hainan's higher vocational colleges and universities is currently observed through various dimensions, including academic papers, patents, projects, teachers' teaching competitions, and teaching achievement awards. The academic paper and patent data are sourced from China Knowledge Network (CNKI), while the project establishment data is obtained from project announcement documents issued by the Hainan Department of Education, Science and Technology Department, and Federation of Social Science and Technology. The information on teachers' teaching competitions and awards for teaching achievements is obtained from the list of award-winning projects announced by the Hainan Department of Education. The time frame for this study is from 2020 to 2022.

As of 2022, there are 14 independent higher vocational colleges and universities in Hainan, which are the statistical objects of this analysis (Table 1). The statistical timeframe

for this analysis is from January 1, 2020, to December 31, 2022, based on publicly released data across multiple dimensions.

**Table 1**

*Overview of Hainan's higher vocational colleges and universities*

| School Name | Location | Nature Of Organization | Foundation Date of School | Short Title | Note |
|---|---|---|---|---|---|
| Hainan College of Economics and Business | Haikou | Public Schools | 2004 | JM | National double-high C-grade institutions, provincial dual institutions of higher vocational education, national backbone higher vocational institutions |
| Hainan Vocational University | Haikou | Mixed-Ownership School | 2000 | HZ | Provincial dual institutions of higher education |
| Hainan Vocational College of Politics and Law | Haikou | Public Schools | 2003 | ZF | Provincial High-Level Professional Group |
| Hainan College of Software Technology | Qionghai | Public Schools | 2003 | RJ | Provincial dual institutions of higher vocational education |
| Hainan College of Foreign Studies | Wenchang | Public Schools | 2003 | HW | Provincial dual institutions of higher vocational education |
| Hainan Provincial Sports Academy | Haikou | Public Schools | 2016 | HT | |
| Hainan Technology and Business College | Haikou | Private Schools | 2004 | GS | Provincial High-Level Professional Group |
| Hainan Health Management College | Chengmai | Private Schools | 2016 | JK | |
| Hainan Health Vocational College | Haikou | Public Schools | 2021 | WS | Provincial High-Level Professional Group |
| Hainan Vocational University of Science and Technology | Haikou | Private Schools | 2007 | KJ | Provincial dual institutions of higher vocational education |
| Sanya Aviation and Tourism College | Sanya | Private Schools | 2005 | HK | Provincial dual institutions of higher vocational education |
| Sanya Institute of Technology | Sanya | Private Schools | 2009 | LG | Provincial High-Level Professional Group |
| Sanya City College | Sanya | Private Schools | 2001 | CS | Provincial High-Level Professional Group |
| Hospitality Institute of Sanya | Sanya | Private Schools | 2017 | ZR | Provincial High-Level Professional Group |

*Research design and indicator system*

Referring to the pyramid model of teacher law index measurement in higher vocational colleges and universities, constructed by recent scholars such as Wang and Wei (2025). and the observation dimensions of scientific research achievement data in higher vocational colleges and universities, constructed by scholars such as Lu and Wang (2023), this research focuses on research design. The assessment of teaching and research ability in higher vocational colleges and universities is analyzed based on scientific research ability, academic thesis, subject, and patents. Additionally, the level of teachers' teaching development is observed through teaching achievement awards and competitions.

The indicator system for measuring the teaching and research capacity of Hainan higher vocational colleges and universities was constructed based on their teaching and research achievements in academic papers, projects, patents, teachers' awards in teaching competitions, and awards for teaching achievements. Table 2 shows the structure of the system, which includes 5-level first-level indicators and 12-level secondary indicators.

**Table 2**

*Weights of Indicators for Measuring the Teaching and Research Capacity of Higher Vocational Colleges and Universities in Hainan*

| Indicator | First level indicators | Variable names | Weighting at the first level | Secondary indicators | Variable names | Weighting at the second level |
|---|---|---|---|---|---|---|
| Teaching and research capacity $Y$ | Paper | $A_1$ | 0.1681 | Number of articles published in core journals | $B_1$ | 0.6365 |
| | | | | Number of articles published in ordinary journals | $B_2$ | 0.3635 |
| | Project | $A_2$ | 0.2008 | Number of projects established by the Department of Education of Hainan Province | $B_3$ | 0.2973 |
| | | | | Number of projects established by the Department of Science and Technology of Hainan | $B_4$ | 0.4077 |
| | | | | Number of projects established by Hainan Provincial Social Science Academic | $B_5$ | 0.2950 |
| | Patent | $A_3$ | 0.2672 | Number of patent applications for inventions | $B_6$ | 0.5957 |
| | | | | Number of utility model patent applications | $B_7$ | 0.4043 |
| | Teachers competition awards | $A_4$ | 0.2281 | Number of first prizes | $B_8$ | 0.2721 |
| | | | | Number of second prizes | $B_9$ | 0.4415 |
| | | | | Number of third-prize | $B_{10}$ | 0.2864 |
| | Teaching achievement awards | $A_5$ | 0.1358 | Number of first prizes | $B_{11}$ | 0.6975 |
| | | | | Number of second prizes | $B_{12}$ | 0.3025 |

*Data analysis*

The method of combining quantitative and descriptive analysis was used to analyze the teaching and research ability of Hainan's higher vocational colleges and universities. The extreme value processing method and entropy value method were used for data analysis to construct an index system for measuring the teaching and research ability of higher vocational colleges and universities. The teaching and research ability of Hainan's 14 higher vocational colleges and universities was comprehensively assessed based on this index system.

Entropy is a parameter used in thermodynamics to describe the state of matter. Its physical meaning is to represent the degree of disorder in the system. The entropy method uses information entropy to judge the degree of discreteness of data, thereby judging the effectiveness and value of evaluation indicators. Among them, the higher the degree of discreteness, the greater the entropy value, and the corresponding weight of the index is also greater, and vice versa. Based on this, this study used the entropy method to calculate the comprehensive development index of higher vocational education, scientific and technological innovation, and social economic development. The specific calculation steps are as follows.

1) Indicator normalization

In this formula (1), let $x_{ij}$ the original data of indicators, $x'_{ij}$ be the standardized data after processing, The minimum value of the sample data is represented by $X_{\min}$, while $X_{\max}$ represents the maximum value.

$$x'_{ij} = \frac{x_{ij} - x_{min}}{xmin_{max}} (\, i = 1,2,\cdots,m; j = 1,2,\cdots,n), \quad \text{.....(1)}$$

2) Calculation of entropy values of evaluation indicators

Let $E_j$ be the information entropy of the $j$th indicator; let $K = \frac{1}{\ln m}$ be a constant; $P_{ij} = x'_{ij} / \sum_{i=1}^{m} x'_{ij}$, be the proportion of the $i$ th unit $j$ th indicator to that indicator, then:

$$E_j = -K \sum_{i=0}^{m} (P_{ij} ln\, P_{ij}) \text{..... (2)}$$

To avoid the situation of $ln = 0$, when $Pij = 0$, let $Pij = 0.0000001$.

3) Calculation of weights of evaluation indicators

Let $W_j$, be the entropy value (weight) of the $j$ th indicator, then:

$$W_j = \frac{1 - E_j}{\sum_{j=1}^{n} (1 - E_j)} \text{.....(3)}$$

Among them, for the $j$ th indicator, the heavier the entropy weight, the greater the impact of the indicator on the system, and vice versa.

To avoid a composite assessment score that is too small, the standardized values were shifted to a range between 1 and 2.

## Empirical analysis and results

### *Academic publications*

#### *Issuance of academic journal papers in the first unit*

Academic journal papers are crucial for conveying scientific research and serve as a key reference for measuring its quality. The quantity of academic journal articles indicates the scientific research status of Hainan's higher vocational colleges and universities, including their research activity and the strength of their scientific research, as demonstrated by the number of core journal articles. To collect data for an academic paper, the China Knowledge Network's 'advanced search' feature was used. The category of 'academic journals' in specific higher vocational college or university's 'first unit' and the desired 'year of publication' were the search criteria. The publication year range was from 2020 to 2022. This data included papers published in academic journals from 14 higher vocational colleges and universities in Hainan. The scientific research situation of Hainan's higher vocational colleges and universities is observed through two dimensions: the total number of papers published in academic journals and the total number of papers published in authoritative journals.

Figure 1 shows the total number of papers published in CNKI from 2020 to 2022 by 14 higher vocational institutions in Hainan. In this period, these institutions published a total of 1,876 papers, with an average of 134 papers per school. According to Figure 1, schools that publish more papers than the average are considered active issuing institutions. Among the top 6 higher vocational colleges and universities, their total number of papers published is above average. JM stands out with 455 papers issued, which is more than three times the average number of papers issued by Hainan's various higher vocational colleges and universities from 2020-2022. There are eight higher vocational colleges and universities whose total number of published papers is below average. Among them, LG and four other higher vocational colleges and universities have published less than 100 papers. WS was established in 2021 and published a total of 10 papers in the two years before the statistical year 2022. The number of published papers in academic journals from 2020 to 2022 for HT and WS is 0.

#### *Number of articles published in core journals*

The number of papers published in core journals can be seen as an indicator of the scientific research capabilities of higher vocational colleges and universities. This count is based on the publication of papers in these types of core journals: Peking University core journals, CSSCI, and CSCD. In 2020-2022, the 14 higher vocational colleges and universities in Hainan will publish a total of 229 papers in core journals. On average, each school will

publish 16 core papers. There are six active issuing higher vocational colleges and universities that will publish several core journals above the average value. Of these, five are provincial dual institutions of higher education, and ZF is a provincial high-level professional group institution. The top three active issuing higher vocational colleges and universities are the main contributors to the academic research of higher vocational colleges and universities in Hainan. The total number of academic journals issued by this institution is nearly equivalent to the combined number issued by the other 11 institutions. Figure 1 indicates that the academic journals of Hainan's higher vocational colleges and universities exhibit a long-tail effect of head aggregation. KJ and JM have the same number of core journals, exceeding the average number of published articles by more than three times. The number of articles published in ZR's core journals has significantly increased compared to previous years, with a sudden rise to 7. However, none of the four colleges and universities (CS, HT, JK, and WS) have any core journals, except for WS which has one academic journal publication. There are no statistics available for academic journal publications. There is a positive correlation between scientific research strength and institutional strength. Therefore, CS, HT, JK, and WS should prioritize scientific research to enhance their professional competitiveness and improve the institution's soft power, which will aid in the development of institutional decision-making.

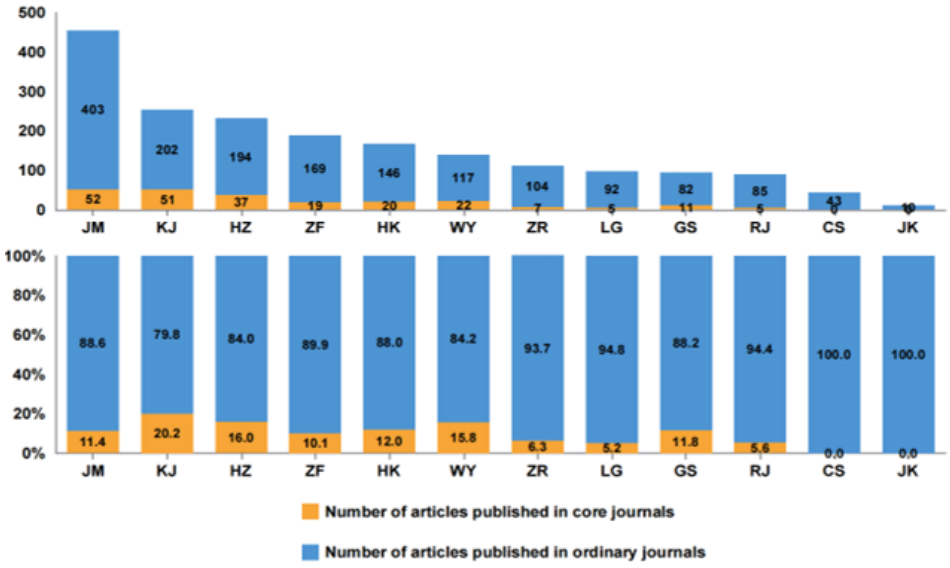


**Figure 1:** The number of papers published by 14 higher vocational colleges and universities in Hainan from 2020 to 2022.

Figure 2 shows that Hainan's higher vocational colleges and universities mainly publish core journal articles in Peking University's (PKU) core journals. JM and KJ have the highest number of articles published in PKU's core journals, and the total number of articles published in PKU's core journals by the four institutions, JM, HK, HZ, and WY, accounts for 70% of the total number of core journals published by all higher vocational colleges and universities. Seven higher vocational colleges and universities have published core journal

articles in CSSCI. Among them, JM, KJ, and ZF have published more than five articles. Seven colleges and universities publish core journal articles in CSCD. KJ has the highest number of articles at 18, which is twice as many as JM. The number of articles in HK is second only to economics and trade. Four institutions have not published any articles in the three core journals: JK, WS, CS, and HT.

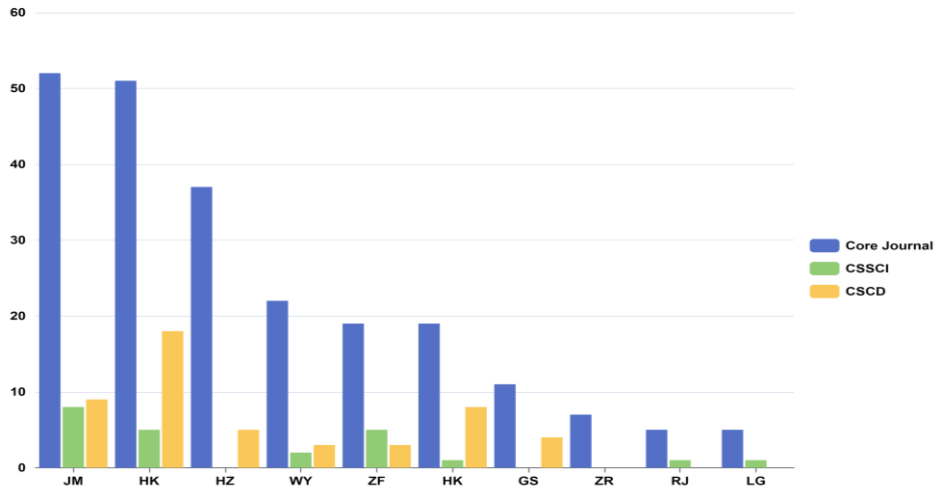


**Figure 2**: Total number of core journal articles issued by 14 higher vocational colleges and universities in Hainan from 2020 to 2022.

*Publications in specialized subcategories*

CNKI's database divides specialty categories into 19 major and 99 minor categories, covering all fields of the national economy. This classification system follows the Chinese library classification system and the Catalogue of Specialties of Higher Vocational Education (Specialties) in the Ordinary Institutions of Higher Education Policy issued by the Ministry of Education in 2015. It is important to note that this classification system is widely used in higher vocational colleges and universities. Journal papers that use this classification system for statistics can meet the needs of various scientific research subjects within the same specialty for comparing research achievements. By publishing papers in each specialty, we can observe the activity and competitiveness of different types of colleges and universities in various disciplines and specialties. This helps to avoid errors caused by subjective classification and ensures a certain degree of objectivity in the analysis results.

Due to the absence of statistics related to academic papers in the KJ CNKI database, professional subcategory paper analysis does not include a comparative analysis of KJ. The statistics of the top 5 professional subcategories of papers issued by 13 higher vocational colleges and universities in Hainan are shown in Figure 3. Teaching papers on higher vocational education are the main focus of academic research in Hainan's higher vocational colleges and universities. As shown in Figure 3, the majority of papers issued by higher

vocational colleges and universities are in the education category, which is the primary area of research. The concentration of theses published in the specialized subcategory is in the education category. This suggests that higher vocational colleges and universities are prioritizing the reform of vocational education to promote connotation construction. They are focusing on improving and enriching the theory of higher vocational education, conducting educational and teaching research on talent cultivation, and researching the laws of vocational education. To some extent, the number of papers published in smaller categories highlights the professional characteristics of higher vocational colleges and universities, which are influenced by different industry backgrounds and professional layouts. Upon comparing the 13 Hainan higher vocational colleges and universities in smaller categories, it can be observed that the number of papers published by the institutions reflects their subject specialties and advantages. They closely focus on the construction of the Hainan Free Trade Port to develop the industrial sector's advantageous characteristics of the profession.

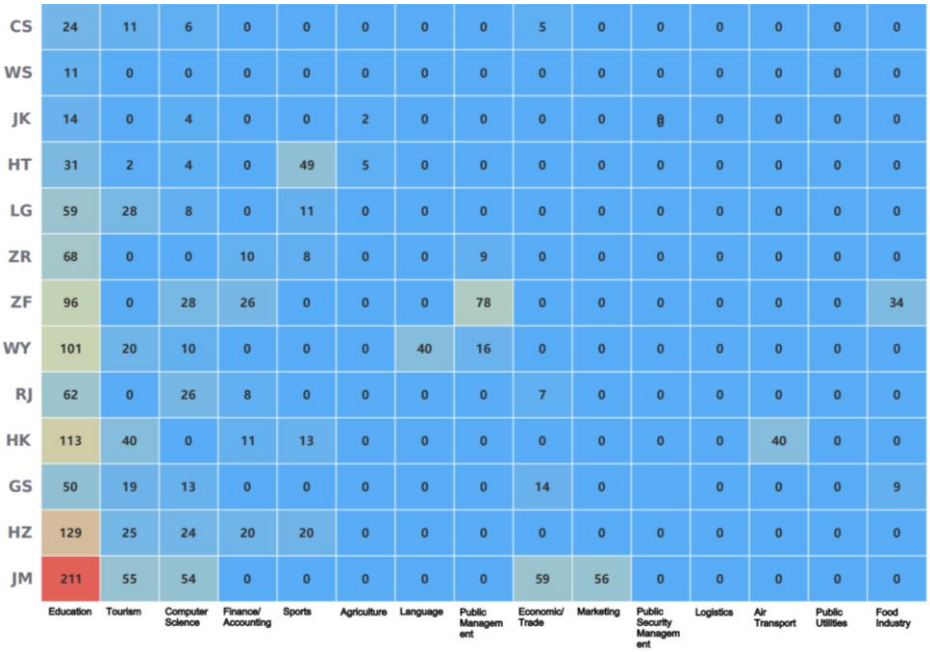


**Figure 3:** Publication volume of the top 5 specialized subcategories among 13 higher vocational colleges and universities in Hainan from 2020 to 2022.

JM is a national double-high C-grade institution and a provincial dual institution of higher vocational education. Its double-high professional groups are tourism management and international economics and trade. The number of articles published in tourism, economics and trade, logistics, and financial accounting corresponding to the professional groups is almost the same, with more than 50 articles. The number of articles published in the tourism, economic and trade, logistics, and financial accounting categories of the specialty groups is almost equal, with more than 50 articles in each category. JM has increased research on hot issues of vocational education with connotation construction as

the main focus to promote the construction of double-high programs. The number of papers published in HZ's education, tourism, finance, accounting, and other management and arts majors is higher than that in agriculture, computer science, and other science and technology majors. The top 5 major subclasses include science and technology, and management and arts majors, which reflects the comprehensiveness of HZ. RJ, WY, and ZF are three institutions with distinctive professional characteristics. RJ specializes in computer science, WY in language, and ZF in public security and justice. The number of papers published in these professional subcategories fully reflects their industry characteristics and professional advantages. HK's number of papers published in air transportation and tourism highlights the industry advantages and professional characteristics of navigation and air transportation. HT highlights the professional characteristics of sports, while ZR has a higher number of published papers in tourism than in education, which fully reflects that the university has taken hotels and tourism as the key construction majors.

*The issuance of documents by schools constructed under the "Double-High Program".*

The primary contributor to scientific research achievements in Hainan's higher vocational colleges and universities from 2020 to 2022 is the 'Double-High Plan' construction institutions. JM is the only national 'Double-High Plan' construction institution and accounts for one-third of the total number of papers published in 14 higher vocational colleges and universities in Hainan, as well as 71% of the total number of papers published in academic journals in 6 'Double-High' institutions. JM is the only national 'double-high' construction institution in Hainan. It accounts for one-third of the total number of papers published by 14 institutions of higher vocational education in Hainan and 71% of the total number of papers published in academic journals of all institutions. This makes it the main force and leading institution in the development of higher vocational education in Hainan. The number of published articles exceeds the average for institutions of a similar caliber, including JM, KJ, and HZ. JM has twice the average number of articles published. RJ has published less than 100 articles, indicating a lower level of activity in academic publishing. Therefore, RJ needs to prioritize scientific research, increase investment in this area, and improve academic research. It is important to prioritize scientific research and increase investment in this area to enhance the quality of academic papers. The number of articles published indicates an increase in the degree of activity of schools under the 'Double-High Plan' in the field of vocational education research. They are actively constructing the advantages of the discourse system in the development of Hainan vocational education in the new era through scientific research activities.

*Analysis of scientific paper authors*

1) Authors of academic journals

Authors of scientific papers play a crucial role in the production and dissemination of knowledge in the field of vocational education research. Their active participation is essential for promoting the development of vocational education research, which in turn influences and shapes the ecological composition of this field. Statistical analysis was conducted on the authorship of papers in higher vocational colleges and universities in Hainan, focusing on the top 40 first-author issuing authors from 2020-2022. The 2020

academic papers from 14 higher vocational colleges and universities in Hainan were analyzed, revealing that the papers were mainly concentrated among 500 authors. The highest number of papers issued was 13 (1), while the lowest was 2 (236), with an average of 3 papers per capita. The number of authors who issued papers below the average was 236.

A minority of academics are responsible for the majority of scholarly publications, and there is a quantitative correlation between the frequency of these active academic groups and the number of papers produced. By defining active authors as those with more than 6 papers published between 2020-2022, there are 40 active authors in Hainan Province's higher vocational colleges and universities, accounting for 8% of the total number of first authors. These active authors have published a total of 302 papers, which accounts for 19% of the total number of published papers. This indicates a pyramid stratification phenomenon. The group of active authors has an average of 8 papers per capita. Of the active authors from institutions with above-average publications, 27 are from 'double-high' institutions, accounting for 68%. The remaining 13 active authors are from high-level professional groups and ordinary higher vocational colleges and universities in other provinces, accounting for 32%. Only 1 active author is from HK and RJ as 'double-high' institutions. It is important to note that this is the only active author from HK and RJ as 'double-high' institutions. These results are presented in Table 3.

**Table 3**

*Active Authors of Papers (6 or More Publications) in 14 Higher Vocational Colleges and Universities in Hainan, 2020-2022*

| Serial Number | Author | Unit | Number of Papers | Serial Number | Author | Unit | Number of Papers |
|---|---|---|---|---|---|---|---|
| 1 (One author) | Lin Ting | JM | 13 | 6 (Ten authors) | Chen Xuehua | WY | 7 |
| 2 (Two authors) | Li Yunjia | JM | 12 | | Zheng Xiaoling | JM | 7 |
| | Lin Lin | JM | 12 | | Hui Qing | JM | 7 |
| 3 (Two authors) | Jiang Yanxiang | WY | 10 | | Liu Kang | HK | 7 |
| | Xu Changbin | HZ | 10 | | Fu Huijun | ZF | 7 |
| 4 (Five authors) | Chen Wenyan | HZ | 9 | 7 (Fifteen authors) | Luo Yuxiang | GS | 6 |
| | Qin Yan | JM | 9 | | Li Ming | ZR | 6 |
| | Zhu Yu | JM | 9 | | Guo Weili | ZR | 6 |
| | Xia Bing | WY | 9 | | Cui Lin | KJ | 6 |
| | Wang Mingyan | JM | 9 | | Zhang Pengfei | ZR | 6 |
| 5 (Five authors) | Wang Shuai | KJ | 8 | | Ma Shiwei | GS | 6 |
| | Sun Xing | ZR | 8 | | Li Kang | HT | 6 |
| | Li Hua | JM | 8 | | Feng Shaona | RJ | 6 |
| | Chen Lili | GS | 8 | | Liu Zhenchun | GS | 6 |
| | Fu Yu | JM | 8 | | Xu Lite | JM | 6 |
| 6 (Ten authors) | Song Meijing | KJ | 7 | | Li Shaomin | HZ | 6 |

| | | | | | |
|---|---|---|---|---|---|
| Wu Youjin | ZR | 7 | Hou Junying | JM | 6 |
| Qu Chao | ZR | 7 | Li Shenglin | JM | 6 |
| Kang Li | ZF | 7 | Yang Xiaojuan | JM | 6 |
| Chen Ying | HZ | 7 | Huang Qianxue | JM | 6 |

2) Authors who are active in core journals

The number of active authors in academic journals reflects the author's research ability, quality, and diligence. However, it does not necessarily represent the author's academic level. Therefore, the quality of published papers should be considered more critical, specifically the number of high-quality core journal papers published. High-quality scientific research promotes both vocational education research and the improvement of vocational education practice. The core journal papers included here are limited to academic papers and do not include book reviews, works of art presentations, or other non-academic papers. An active author of core journals is defined as the first author of more than two core journal articles issued by 14 higher vocational colleges and universities in Hainan. After screening, we identified 18 active authors with more than two core journal releases, resulting in a total of 40 releases. Biographical information of active authors can be obtained through the official websites of colleges and universities, as well as literature author profiles. This information can then be used to analyze the authorship of core journal papers.

Male scholars account for 56% of active authors in core journals of Hainan's higher vocational colleges and universities, while female scholars account for 44%. When three or more authors are active, the proportion of men and women is equal. The majority of current studies suggest that male scholars are the main academic force in the field of higher education, and the academic impact of female scholars is increasing. In core journals, only 2 authors hold the title of professor, accounting for 11% of active authors. Among the group of 40-49-year-olds, there is only 1 active author with the title of professor, while 7 hold the title of associate professor, accounting for 39%, and 8 hold the title of lecturer, accounting for 44%. In Hainan's higher vocational colleges and universities, the core journal's active authors are mainly concentrated in the 40-49 age group. Associate professors and above constitute the main force of active authors in the core journal. At this stage, scholars are in a period of career stabilization, and their work skills are greatly improving. With time and experience, they can develop unique scientific research strengths. Hainan's higher vocational colleges and universities should provide more opportunities for post-80s teachers to develop their skills and expertise, enabling them to produce higher-quality academic results. Table 4 presents these findings.

**Table 4**

*Active authors of core journal papers (2 or more publications) in 14 higher vocational colleges and universities in Hainan from 2020 to 2022.*

| Serial Number | Active Author | Unit | Number of Papers | Year of Birth | Gender | Title |
|---|---|---|---|---|---|---|
| 1 | Yang Xiaojuan | JM | 3 | 1980 | Female | Associate Professor |
| | Wang Zihai | ZF | 3 | 1982 | Male | Associate Professor |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Huang Liping | KJ | 3 | 1978 | Female | Lecturer |
| 2 | Bai Youjun | JM | 2 | 1983 | Male | Associate Professor |
| | Guo Lifang | HZ | 2 | 1981 | Female | Associate Professor |
| | He Lu | HZ | 2 | 1987 | Female | Lecturer |
| | Li Li | HZ | 2 | 1977 | Male | Lecturer |
| | Kang Li | ZF | 2 | 1983 | Male | Associate Professor |

**Table 4 (continued)**

*Active authors of core journal papers (2 or more publications) in 14 higher vocational colleges and universities in Hainan from 2020 to 2022.*

| Serial Number | Active Author | Unit | Number of Papers | Year of Birth | Gender | Title |
|---|---|---|---|---|---|---|
| | Wang Xianfa | ZF | 2 | 1981 | Male | Lecturer |
| | Xia Bing | WY | 2 | 1982 | Male | Associate Professor |
| | Chen Lang | WY | 2 | 1980 | Female | Lecturer |
| | Jiang Yanxiang | WY | 2 | 1980 | Male | Lecturer |
| | Feng Lihua | KJ | 2 | 1982 | Female | Lecturer |
| | Li Meicun | KJ | 2 | 1986 | Female | Lecturer |
| | Song Yanpei | KJ | 2 | 1957 | Male | Professor |
| | Liu Xia | HK | 2 | 1983 | Male | Professor |
| | Chen Yuanyuan | LG | 2 | 1985 | Female | Lecturer |
| | Li Ming | ZR | 2 | 1983 | Male | Associate Professor |

*Analysis of project status*

The project is an important evaluation index for scientific research conducted by higher education institutions. The information on vertical topics in Hainan for 2020-2022 was collected from official project documents issued by the Department of Education of Hainan Province, the Department of Science and Technology of Hainan, and Hainan Provincial Social Science Academic. In Hainan, between 2020 and 2022, 14 higher vocational colleges and universities have been approved for a total of 437 projects, averaging 31 projects per school. Figure 4 shows that the total number of projects in these institutions exhibits an 'echelon effect'. Schools with a total number of approved projects above the average are considered active. In 2020-2022, there are six institutions with several projects above the average, mainly JM, KJ, HZ, ZF, RJ, and HK. JM has more than twice the average number of projects, and except for ZF, the other five institutions are 'double-high' institutions. The remaining institutions are also 'double-high' institutions. JM has more than twice as many projects as the average. Except for ZF, the other five institutions are also considered 'double-high' institutions. The total number of projects of the remaining institutions does not reach the average value. It is worth noting that WS was founded more recently and had only half the average number of projects in its first year of operation.

Table 5 shows that in 2020-2022, Hainan's higher vocational colleges and universities approved more than two-thirds of the project topics assessed by the Hainan Education Department. Higher vocational colleges and universities in Hainan focus solely on project

education and education reform as well as scientific research project declarations from the Hainan Department of Education. However, some institutions lack sufficient scientific research capabilities. The number of social science fund projects coordinated by the Hainan Science and Technology Department and the Hainan Provincial Social Science Academic is limited.

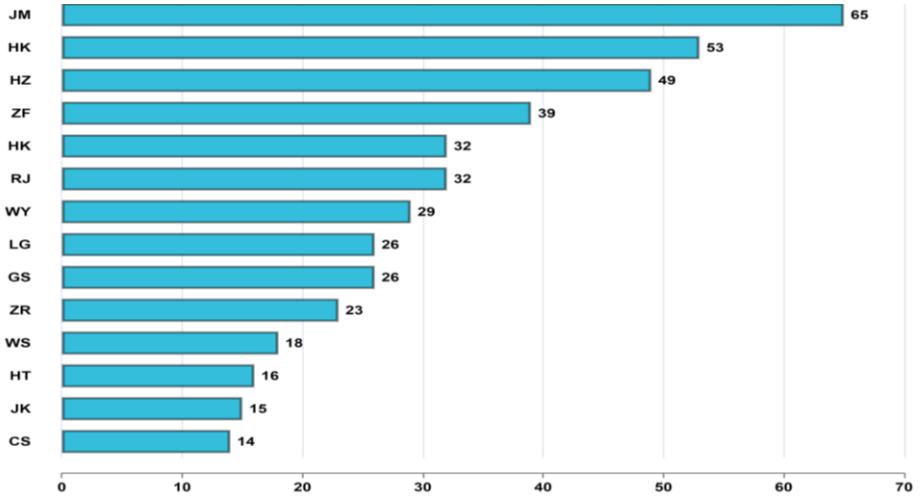


**Figure 4:** The total number of projects in 14 higher vocational colleges and universities in Hainan from 2020 to 2022.

**Table 5**

*Types of Topics to be Offered by 14 Higher Vocational Colleges and Universities in Hainan from 2020-2022*

| No | Unit | Projects supported by Department of Education | Projects supported by Hainan Provincial Social Science Academic | Projects supported by Department of Science and Technology | Total |
|---|---|---|---|---|---|
| 1 | JM | 44 | 9 | 12 | 65 |
| 2 | KJ | 26 | 12 | 15 | 53 |
| 3 | HZ | 37 | 7 | 5 | 49 |
| 4 | ZF | 26 | 5 | 8 | 39 |
| 5 | RJ | 27 | 3 | 2 | 32 |
| 6 | HK | 27 | 1 | 4 | 32 |
| 7 | WY | 26 | 0 | 3 | 29 |
| 8 | GS | 20 | 2 | 4 | 26 |
| 9 | LG | 20 | 0 | 6 | 26 |
| 10 | ZR | 21 | 0 | 2 | 23 |
| 11 | WS | 16 | 0 | 2 | 18 |
| 12 | HT | 14 | 0 | 2 | 16 |
| 13 | JK | 14 | 1 | 0 | 15 |
| 14 | CS | 14 | 0 | 0 | 14 |

The project topics are divided into two categories: education reform and scientific research. The education reform topics focus on the theoretical construction of vocational education and research on the core contents of reform and development. This includes traditional theoretical issues and key policy issues such as talent cultivation, integration of production and education, curriculum construction, double-high programs, and the 1+X certificate system. Scientific research topics center on the construction of Hainan's Free Trade Port and extend outward to include the four major industries in Hainan, international exchanges, and the synergistic development of related industries and the economy.

### *Patent Achievements*

Patents are a crucial aspect of technology research, development, and higher education services. Invention patents serve as a significant indicator of a region's or institution's scientific and technological innovation capabilities. This definition of patents includes both invention and utility model patents but excludes designs. The patent data was collected from CNKI in 2020-2022. Fourteen higher vocational colleges and universities in Hainan applied for 214 patents and obtained 166 patent authorizations. On average, each school was authorized 11.9 patents. Nine out of the 14 higher vocational colleges and universities in Hainan obtained patent authorizations, mainly in the form of 'double-high' colleges and polytechnic higher vocational colleges. Nine out of the 14 higher vocational colleges in Hainan have been granted patents. Most of these patents were obtained by 'double-high' colleges and polytechnic higher vocational colleges. This suggests that these institutions place a greater emphasis on research and development of new technologies and innovations and are more successful in cultivating patent achievements than other colleges and universities.

The number of patent applications can reflect the level of patent awareness and enthusiasm for patent applications among higher vocational colleges and universities. Meanwhile, the number of patent grants can reflect the inventiveness and practicality of patents, which is an indicator of their quality. Table 6 shows that JM has the highest number of patent applications, with 87 applications, which is twice as many as RJ and HZ combined. JM ranks first in the total number of patent authorizations, and the combined total of patents authorized by JM, HZ, and RJ is more than two-thirds of the total number of patents authorized by the 13 higher vocational colleges and universities in Hainan. In terms of the rate of patent authorizations, JM applied for 87 patents from 2020-2022 and obtained 44, resulting in a patent authorization rate of 50%. HZ applied for 42 items and obtained 39, resulting in a patent authorization rate of 92.85%. RJ applied for 38 items and obtained 37, resulting in a patent authorization rate of 97.37%. The patent-obtaining rate of polytechnic institutes' higher vocational colleges and universities is even higher.

Regarding patent categories, all institutions except for HK have a higher authorization rate for utility model patents than for invention patents. In the case of HK, HZ, RJ, and KJ, the authorization rate for invention patents is higher than that for utility model patents. Table 6 also shows that six institutions, HZ, RJ, JM, KJ, HK, and JK, cover both invention patents and utility model patents. JM mainly focuses on invention patents and utility model patents. The number of applications and authorizations of both types of patents in

RJ and HK is relatively average, while JM and HZ pay the most attention to utility model patent applications.

Patents can be used as a measure of a university's level of technological innovation. This reflects the university's disciplinary advantages and scientific research and innovation. By combining the university's advantageous disciplines and patented technology hotspots, local economies can be promoted, and the competitive advantage of colleges and universities can be enhanced. This can help colleges and universities achieve excellent results in discipline competition.

**Table 6**

*The statistics for patent applications and authorizations of 14 higher vocational colleges and universities in Hainan from 2020 to 2022.*

| Unit | Patent application | | | Patent authorization | | |
|---|---|---|---|---|---|---|
| | Number of patent applications | Number of patent applications for inventions | Number of utility model patent applications | Number of patent authorization | Number of patent applications for inventions | Number of utility model patent applications |
| JM | 87 | 44 | 41 | 44 | 12 | 31 |
| RJ | 42 | 14 | 17 | 39 | 13 | 15 |
| HZ | 38 | 7 | 28 | 37 | 8 | 26 |
| KJ | 18 | 14 | 4 | 25 | 22 | 3 |
| HK | 11 | 5 | 6 | 7 | 4 | 3 |
| ZF | 6 | 2 | 4 | 4 | 0 | 4 |
| ZR | 4 | 0 | 4 | 4 | 0 | 4 |
| JK | 3 | 2 | 1 | 3 | 2 | 1 |
| HT | 1 | 0 | 1 | 1 | 0 | 1 |
| WY | 0 | 0 | 0 | 0 | 0 | 0 |
| GS | 0 | 0 | 0 | 0 | 0 | 0 |
| LG | 0 | 0 | 0 | 0 | 0 | 0 |
| CS | 0 | 0 | 0 | 0 | 0 | 0 |
| WS | 0 | 0 | 0 | 0 | 0 | 0 |

*Analysis of pedagogical development among teachers*

According to the index system for measuring the teacher development index of higher vocational colleges constructed by scholars such as Guo and Wang (2020), this text analyzes the teaching development of teachers in Hainan's higher vocational colleges using the two third-level indicators of teaching achievement awards and teacher teaching competitions as the main dimensions. The data on teaching achievement awards for Hainan's higher education institutions is sourced from official announcement documents published by the Hainan Education Department in 2020 and 2022. The information provided includes the name of the achievement, the personnel and unit responsible for completion, the relevant discipline, and the level of the award.

Table 7 presents the teaching achievement awards received by 14 higher vocational colleges and universities in Hainan from 2020 to 2022. A total of 35 awards were won, with 11 first prizes (31.42%) and 24 second prizes (68.57%). On average, each school won less than 3 awards. The top 6 institutions, which include 'double-high' construction institutions

and high-level professional group institutions, won 65.71% of the total awards. The six institutions that received JM awards are all 'double-high' construction institutions and high-level professional group institutions, accounting for 65.71% of the total number of awards, which is more than twice the average number of awards. The research mainly focused on practical exploration, with only one study in the category of teaching materials, which won the second prize.

**Table 7**

*Teaching Achievement Award Winners in 14 Higher Vocational Colleges and Universities in Hainan, 2020-2022*

| Serial number | Unit | First prize | Second prize | Total |
|---|---|---|---|---|
| 1 | JM | 3 | 3 | 6 |
| 2 | HZ | 2 | 2 | 4 |
| 3 | KJ | 2 | 2 | 4 |
| 4 | GS | 1 | 2 | 3 |
| 5 | ZF | 1 | 2 | 3 |
| 6 | HK | 2 | 1 | 3 |
| 7 | LG | 0 | 3 | 3 |
| 8 | RJ | 0 | 2 | 2 |
| 9 | WY | 0 | 2 | 2 |
| 10 | ZR | 0 | 2 | 2 |
| 11 | HT | 0 | 1 | 1 |
| 12 | CS | 0 | 1 | 1 |
| 13 | WS | 0 | 1 | 1 |
| 14 | JK | 0 | 0 | 0 |

The award-winning projects are categorized into project units and project categories. The Teaching Achievement Award completion units are divided into three categories: provincial 'double-high' construction units, provincial high-level professional group construction units, and ordinary higher vocational colleges and universities. Table 8 shows that the provincial 'double-high' construction units received the highest number of awards, accounting for 57.14% of the total awards for teaching achievements among the 14 higher vocational colleges and universities in Hainan. The provincial high-level professional group construction units accounted for 25.71% of the total awards, followed by the provincial 'double-high' institutions. The number of awards received by 'double high' institutions is four times higher than that of other types of institutions. First and second prizes are awarded by 'double high' institutions at the provincial level, with four awards for GS and ZF, and two awards for provincial high-level institutions. 'Double high' and high-level professional group construction units prioritize the cultivation of teaching achievement awards. In terms of award-winning projects, the pedagogy category accounted for the largest proportion, more than 58%, followed by the ideological and political education category, teaching reform category, and others.

The award-winning projects' cooperation is categorized into two types: unit cooperation and individual cooperation. In terms of unit cooperation, 21 out of the total 35 award-winning projects were completed independently by a single unit, accounting for 60% of the total. The remaining 14 projects were completed by more than two units,

accounting for 40% of the total. The Teaching Achievement Award cooperation takes two forms: school-university cooperation and multi-dimensional cooperation. School-school cooperation refers to the collaboration between higher vocational colleges and other educational institutions, such as undergraduate colleges, secondary schools, kindergartens, and elementary schools. This type of cooperation accounts for 11.43% of the total number of presidential counts and involves four items. On the other hand, multi-dimensional cooperation involves higher vocational colleges, universities, enterprises, industries, governments, institutions, and social organizations. This type of cooperation accounts for 37.14% of the total number of presidential counts and includes 13 items. This fully reflects the new pattern of the integration of industry and education. Regarding the completion of the results, only one project (second prize) was completed independently by one person, while only one project (first prize) had 30 or more collaborators. The number of collaborators in other projects was mostly concentrated between 5-10 people. Therefore, the Teaching Achievement Prize emphasizes team cooperation. The personnel involved in the project include enterprise personnel, school administration leaders, and full-time teachers, resulting in a diverse team. However, it is important to note that projects led by school leaders are more common, and administrative teachers make up a larger portion of the team. Full-time teachers without administrative positions have a lower participation rate.

**Table 8**

*The distribution of Teaching Achievement Award winners among 14 higher vocational colleges and universities in Hainan from 2020 to 2022.*

| Type of unit | Number of first prizes | Number of second-prize | Percentage | Number of units |
|---|---|---|---|---|
| Provincial 'double-high' construction units | 9 | 11 | 57.14% | 6 |
| Provincial high-level professional group construction units | 2 | 7 | 25.71% | 3 |
| Ordinary higher vocational colleges | 0 | 4 | 11.43% | 4 |

Vocational College Skills Competition, Teaching Ability Competition, and Young Teachers Teaching Competition are important forms and effective extensions of educational and teaching activities in vocational colleges and universities. They are the main ways to improve the educational and teaching levels of teachers. Teacher teaching competitions typically refer to competitions that assess teaching abilities in higher vocational institutions and young teachers. The total number of awards in 2021 is lower than that of 2020 and 2022. This is mainly due to the biennial Young Teachers' Teaching Competition. In 2022, the total number of awards was expected to be 85, which is twice the number of awards in 2020. Table 9 presents the awards for teacher teaching competitions in 14 higher vocational institutions in Hainan from 2020 to 2022. The institutions won a total of 181 awards, averaging about 13 awards per institution. Seven institutions won more than the average number of awards.

Table 9 shows that JM won half of the total number of first-prize awards, indicating its importance in teachers' teaching competitions. The institution always emphasizes student-centered teaching and deepens the reform of teaching materials and methods. WS, CS, LG, and JK did not have any first prize-winning projects for three consecutive years, highlighting the significance of improving the importance of teachers' teaching competitions at the school level to promote teaching through competition. The school administration should prioritize teachers' participation in teaching competitions to enhance the quality of education.

**Table 9**

*Awards for Teachers' Teaching Competitions in Hainan's 14 higher vocational colleges and universities, 2020-2022*

| Serial Number | Unit | Number of first prizes | Number of second-prize | Number of third-prize | Total |
|---|---|---|---|---|---|
| 1 | JM | 15 | 10 | 5 | 30 |
| 2 | ZF | 1 | 10 | 13 | 24 |
| 3 | HK | 2 | 10 | 11 | 23 |
| 4 | RJ | 3 | 11 | 8 | 22 |
| 5 | KJ | 2 | 5 | 11 | 18 |
| 6 | HZ | 4 | 5 | 8 | 17 |
| 7 | ZR | 3 | 2 | 8 | 13 |
| 8 | GS | 1 | 2 | 8 | 11 |
| 9 | WY | 3 | 2 | 5 | 10 |
| 10 | WS | 0 | 5 | 3 | 8 |
| 11 | LG | 0 | 1 | 6 | 7 |
| 12 | CS | 0 | 0 | 6 | 6 |
| 13 | JK | 0 | 1 | 4 | 5 |
| 14 | HT | 1 | 0 | 4 | 5 |

Table 10 displays the awards for the Teaching Competence Competition of Hainan Higher Vocational Colleges and Universities in 2020-2022. The group of public basic courses received 29 awards, with an award rate of 16.29%. The group of professional courses received 103 awards, with an award rate of 57.87%. The group of professional courses also received 46 awards, with an award rate of 25.84%. Professional courses receive the most awards due to their ability to effectively combine professional characteristics with industry background advantages, fostering innovation. However, the success of these courses is also dependent on the degree of attention given to their cultivation by higher vocational colleges and universities. On the other hand, public foundation courses have the lowest award rate due to their theoretical knowledge bias and lack of integration with practical teaching. Improvements are needed in the course design to increase engagement and novelty.

JM's public foundation group and professional course group received the most awards, demonstrating JM's commitment to deepening the 'Three education reform' and emphasizing the importance of cultivating teaching competence through competition courses. This achievement also highlights JM's dedication to internalizing the construction and serving as a model for 'double-high' construction institutions. There are seven

institutions with fewer than ten awards. These institutions should prioritize the improvement of their teachers' teaching abilities and actively work towards building a high-level teaching team.

**Table 10**

*Awards for Course Groups in the Teaching Competitiveness Competition 2020-2022 in 14 Higher Vocational Colleges and Universities in Hainan Province*

| No | Unit | Group of public basic courses | Group of professional courses Ⅰ | Group of professional courses Ⅱ | Total |
|---|---|---|---|---|---|
| 1 | JM | 5 | 17 | 3 | 25 |
| 2 | ZF | 4 | 14 | 6 | 24 |
| 3 | RJ | 3 | 16 | 3 | 22 |
| 4 | HZ | 3 | 8 | 8 | 19 |
| 5 | HK | 2 | 13 | 4 | 19 |
| 6 | KJ | 2 | 13 | 1 | 16 |
| 7 | ZR | 2 | 6 | 5 | 13 |
| 8 | WY | 1 | 5 | 2 | 8 |
| 9 | GS | 1 | 1 | 5 | 7 |
| 10 | LG | 1 | 3 | 2 | 6 |
| 11 | CS | 2 | 1 | 2 | 5 |
| 12 | WS | 0 | 4 | 1 | 5 |
| 13 | JK | 1 | 1 | 3 | 5 |
| 14 | HT | 2 | 1 | 1 | 4 |
| Total | | 29 | 103 | 46 | 178 |

*Comprehensive assessment of teaching and research capacity*

The teaching and research capacity assessment indicators of Hainan higher vocational colleges were standardized and calculated using formula (1), (2), and (3), as presented in Table 11.

**Table 11**

*Standardized values of teaching and research ability measurement indicators for Hainan higher vocational colleges and universities*

| Unit | Number of papers | Number of projects | Number of patents | Number of teacher's competition awards | Number of teaching achievement awards |
|---|---|---|---|---|---|
| CS | 1.09 | 1.00 | 1.00 | 1.04 | 1.17 |
| GS | 1.20 | 1.24 | 1.00 | 1.24 | 1.50 |
| HZ | 1.51 | 1.69 | 1.65 | 1.48 | 1.67 |
| HK | 1.36 | 1.35 | 1.16 | 1.72 | 1.50 |
| JK | 1.00 | 1.02 | 1.07 | 1.00 | 1.00 |
| JM | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 |
| LG | 1.21 | 1.24 | 1.00 | 1.08 | 1.50 |
| RJ | 1.20 | 1.35 | 1.65 | 1.68 | 1.33 |
| HT | 1.00 | 1.04 | 1.02 | 1.00 | 1.17 |
| WY | 1.31 | 1.29 | 1.00 | 1.20 | 1.33 |
| WS | 1.02 | 1.08 | 1.00 | 1.12 | 1.17 |

| | | | | | |
|---|---|---|---|---|---|
| ZF | 1.41 | 1.49 | 1.09 | 1.76 | 1.50 |
| ZR | 1.24 | 1.18 | 1.09 | 1.32 | 1.33 |
| KJ | 1.56 | 1.76 | 1.49 | 1.52 | 1.67 |

The comprehensive score of teaching and research ability of Hainan higher vocational colleges and universities is calculated according to formulas (4) and (5). The results are then ranked and presented in Table 12.

$$A_i = \sum_{i=1}^{n} B_i \times W_{2i}, \quad i = 1,2 \cdots n \ldots \ldots (4)$$

$$Y = \sum_{i=1}^{n} A_i \times W_{1i}, \quad I = 1,2 \cdots n \ldots \ldots (5)$$

Among them, $A_i$ is the *i-th* school first-level indicators evaluation score. $B_i$ is the *i-th* school first-level indicators evaluation score. $W_{1i}$ and $W_{2i}$ are the weights of first-level indicators and second-level indicators. $n$ indicates the number of indicators. $Y$ is the comprehensive assessment score of the *i-th* school.

**Table 12**

*Comprehensive score and ranking of teaching and research capabilities of higher vocational colleges and universities in Hainan*

| No | Unit | Comprehensive score | Rank |
|---|---|---|---|
| 1 | JM | 85.32 | 1 |
| 2 | KJ | 66.70 | 2 |
| 3 | HZ | 57.16 | 3 |
| 4 | RJ | 41.78 | 4 |
| 5 | ZF | 38.82 | 5 |
| 6 | HK | 38.65 | 6 |
| 7 | GS | 19.05 | 7 |
| 8 | WY | 16.99 | 8 |
| 9 | ZR | 15.67 | 9 |
| 10 | LG | 12.97 | 10 |
| 11 | WS | 7.29 | 11 |
| 12 | JK | 4.37 | 12 |
| 13 | CS | 3.98 | 13 |
| 14 | HT | 3.57 | 14 |

Figure 5 shows the assessment scores of teaching and research capabilities of Hainan's higher education institutions in 2020-2022, revealing a two-tier division. JM, a national dual-higher education institution, stands alone, while HZ and RJ, two provincial dual-higher education institutions, follow closely, ranking in the second echelon with a noticeable gap. HK and ZF, two dual-higher education institutions in the province, belong to the third echelon, with a gap of nearly 20 points between them and the second echelon institutions. ZR, GS, and WY are in the fourth echelon, and the remaining five institutions are in the fifth echelon.

The distinction between high-level institutions and the rest is evident. Schools should prioritize understanding the connotation of their construction and focus on teaching and

research. Innovative teaching and research teams should lead the way and drive teachers to produce more results in these areas, ultimately enhancing the soft power of the school.

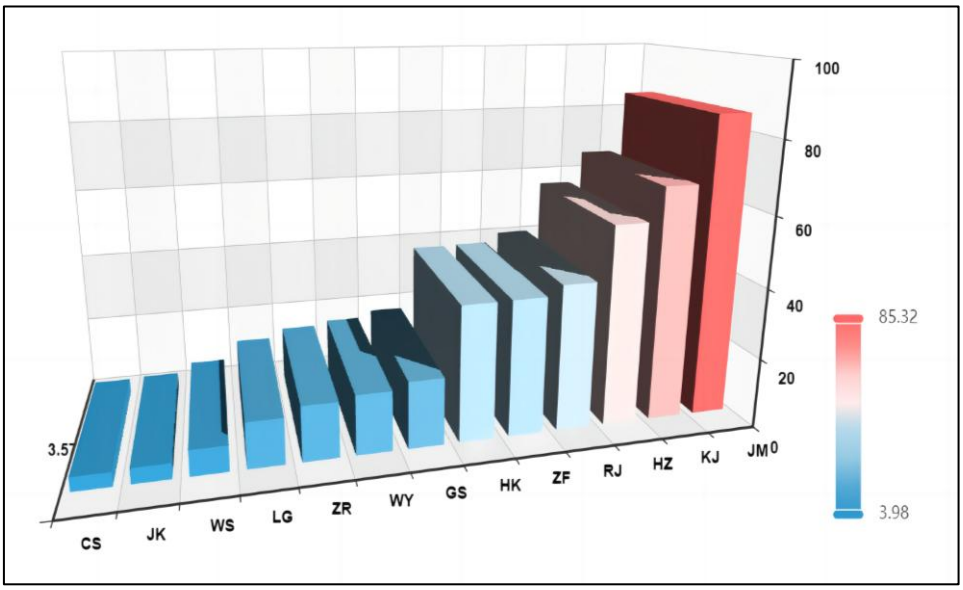


**Figure 5:** Schematic diagram of how to measure the teaching and research capacity of Hainan's higher vocational colleges and universities from 2020 to 2022.

## Discussion

This study evaluates the teaching and research capabilities of 14 higher vocational colleges in Hainan using a multi-dimensional framework. The findings underscore both strengths and areas for improvement, offering a detailed comparison with prior research and critical analysis of the results. Additionally, the results highlight significant systemic challenges, including a focus on quantity over quality, limited national-level achievements, and gaps in regional and institutional collaboration.

### *Strengths and Alignment with Prior Research*

#### *Academic Outputs*

The concentration of high-quality academic papers in double-high institutions such as JM mirrors the findings of Merton (1973) cumulative advantage theory, where elite institutions tend to dominate due to better resources and expertise. However, as highlighted in the comparative analysis, 88% of academic papers published by Hainan's vocational colleges are in ordinary journals, indicating an overemphasis on quantity over quality. This aligns with Geuna and Martin (2003) observations on the unequal distribution of research capabilities but also underscores the early developmental stage of research capabilities in Hainan.

### *Regional Relevance*

The predominance of research topics focused on Hainan Free Trade Port development and local industries reflects a strategic alignment with regional needs. This resonates with Chan (2015), who emphasized the importance of contextual research that contributes to local socio-economic development. However, the separation between industry, academia, and research often results in limited high-quality patents that can be quickly applied to enterprise production, indicating a need for closer integration of research and industry.

### *Patents and Innovations*

The emphasis on utility patents over invention patents highlights the practical orientation of vocational colleges, as noted by Haapakorpi (2017) in European vocational institutions. The near-perfect patent authorization rates for some colleges, such as RJ, demonstrate the effectiveness of their applied research strategies. However, the study identifies a significant disparity in patent quality and rapid application, which may hinder impactful innovation.

### *Pedagogical Development*

The robust participation and achievements in teaching competitions showcase the integration of teaching and research, echoing Pan Maoyuan's advocacy for dual-focus faculty roles. Wang (2022) support such practices, highlighting competitions as a pathway to improve quality, improve teaching innovation and professional competence. Nevertheless, national-level teaching achievements remain sparse, with only one institution (JM) receiving a National Teaching Achievement Award, highlighting the need to elevate the quality of pedagogical development.

## *Areas for Improvement and Divergences*

### *Research Activity Disparity*

Institutions like HT and WS show minimal contributions to core journals and patents, reflecting challenges in achieving research excellence. This disparity may stem from unequal resource allocation, as discussed by Geuna and Martin (2003), and requires targeted policy interventions. Additionally, the gap in teaching and research development between double-high institutions and general colleges results in a "long-tailed phenomenon," where general institutions struggle to achieve impactful outcomes.

### *Limited High-Impact Research*

While the volume of research output is commendable, the relatively low representation in core journals suggests that research quality requires enhancement. Zhao et al. (2022) emphasized the need for structured frameworks to raise publication standards. Furthermore, the study highlights that current subject management practices focus heavily on process completion, often at the expense of result quality.

*Collaboration Deficit*

The low levels of collaborative projects, especially interdisciplinary and multi-institutional ones, hinder broader impacts. Boyd et al. (2005) argued that collaboration often enhances innovation and application. Similarly, limited collaboration between industry and academia exacerbates the separation between teaching, research, and production (Zhang & Chen, 2023).

*Gender and Career Stage Bias*

Male scholars dominate high-impact publications, while younger faculty remain underrepresented. This aligns with Chan (2015) findings on systemic biases in academia, which vocational colleges must address through mentorship and career development programs.

## Conclusion

This study highlights the dynamic capabilities and challenges of Hainan's higher vocational colleges. Key findings include the concentration of academic excellence in double-high institutions, strong alignment with regional needs in research topics, and significant achievements in teaching competitions. However, disparities in research activity, limited high-impact outputs, gaps in collaboration, and an overemphasis on quantity over quality remain areas for growth. The lack of national-level teaching and research achievements further underscores the need for systemic changes. Addressing these issues will require targeted policy interventions, such as improving resource distribution, fostering inter-institutional collaborations, and supporting underrepresented faculty groups. These measures can enhance the institutions' contributions to regional development and their global competitiveness.

The study faced a few limitations. First, the study relied on a limited publicly available data, which may not fully capture internal initiatives and informal collaborations. Future studies should incorporate qualitative data, such as interviews and focus groups, for a more nuanced understanding. The findings are also specific to Hainan region and may not generalize to other provinces with different economic and educational contexts. Comparative studies across regions are necessary for broader insights. Third, the study covers 2020–2022, a period influenced by global disruptions like the COVID-19 pandemic, which may have affected institutional performance metrics. Finally, the study relies on quantitative indicators such as publication counts and patent numbers, which may overlook qualitative aspects of teaching and research impact. A balanced evaluation system should incorporate both qualitative and quantitative measures to better reflect institutional performance.

Policymakers should prioritize resource redistribution to support less active institutions like WS and HT, enabling them to develop competitive teaching and research capacities. Additionally, funding mechanisms should incentivize quality over quantity, encouraging institutions to focus on impactful research and teaching outcomes. Expanding

partnerships with industries and leveraging Hainan Free Trade Port initiatives could amplify the practical relevance of vocational education research. Schools should move classrooms into enterprise workshops, allowing teachers and students to gain practical exposure while aligning academic outputs with industry needs. Introducing structured mentorship and professional development programs for younger and underrepresented faculty can enhance diversity and innovation in research outputs. Categorized training plans should focus on teaching and research foundations, professional development, and disciplinary specialization. Establishing stricter criteria for research funding and performance reviews can incentivize high-impact publications and innovative patents, as suggested by Mazlish (1982). A sustainable evaluation system tailored to vocational education characteristics should emphasize both process and results to avoid ethical and academic quality issues. Encouraging inter-institutional collaborations through funding and policy incentives can drive interdisciplinary research and innovation, aligning with Taylor and Tyler (2012) advocacy for collaborative frameworks. Sharing mechanisms, such as joint conferences, seminars, and research projects, can help bridge the gaps between institutions and promote mutual growth.

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