

Factors influencing professional development of double-qualified teachers in Guangxi Zhuang Autonomous Region, China



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ABSTRACT

This study explores the factors affecting the professional development of double-qualified teachers (DQTs) in the Guangxi Zhuang Autonomous Region. Using structural equation modeling, it examines how institutional support, continuous training, school-enterprise cooperation, resource availability, and progressive educational policies contribute to DQTs' growth. Data were collected through structured questionnaires distributed to DQTs, educational administrators, and policymakers, with reliability and validity tests confirming the robustness of the instruments. The results show that resource availability is the most significant factor, followed by continuous training and educational policies, while institutional support has a lesser effect. Notably, school-enterprise cooperation demonstrates a negative relationship, suggesting current partnerships are ineffective. These findings highlight the importance of providing sufficient resources, expanding professional development opportunities, and innovating curriculum design and delivery. The study recommends that policymakers and educational leaders in Guangxi prioritize resource enhancement, program quality improvement, and policy innovation, while addressing weaknesses in school-enterprise collaborations to strengthen vocational education. Future research should further investigate these variables to develop more effective support systems and collaborative practices for the sector's evolving needs.

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1. Introduction

The professional development of teachers is crucial for improving the quality of education and educational outcomes. In Chinese higher vocational education, double-qualified teachers (DQTs) hold special significance. DQTs are teachers who have both practical and theoretical teaching competencies and command contemporary teaching strategies and techniques based on the Ministry of Education of the People's Republic of China. They are important in improving vocational education because of their unique blend of scholarly and practical knowledge, which aids educational institutions in skillfully orienting students.

Due to its rich ethnic diversity and fast economic development, the Guangxi Zhuang Autonomous Region is an exceptional area for formulating DQT

strategies. The region has some distinctive educational problems, for instance, the gap in educational materials, language, and culture (Grey, 2019). Economic policies like the Beibu Gulf Economic Zone and the China-ASEAN Free Trade Area put an emphasis on having a readily available skilled workforce that can quickly adapt to changing industrial requirements (Zhang, 2021). In this situation, DQTs act as a critical linkage between the local industries and the theoretical training offered in educational institutions.

The professional development of DQTs in Guangxi is impacted by various factors, such as government policies, professional development, and educational institution–industry relations (Xu and Sarino, 2023). Moreover, the factors such as institutional backing, availability of materials with training, prospects of professional cooperation, as well as forward-looking educational policy are vital in bolstering the effectiveness of vocational education (Kravchenko et al., 2020; Zongkeng et al., 2021).

Even with the seeming importance of DQTs in vocational education, there still exists a gap in the literature regarding the professional development issues in the context of DQTs in regions like Guangxi.

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A majority of the literature attempts to address the overarching concern of DQTs but fails to provide a nuanced understanding of the specific opportunities and challenges of professional development in the region (Cheng et al., 2025; Wen and Li, 2024). Research on Guangxi is long overdue because of its particular sociocultural and economic context, which directly warrants the study of regional policy execution, the status of local professional development services, and synergies between vocational education and industry (Kuang et al., 2025).

This study attempts to fill this gap by looking into the factors influencing DQTs' professional development in Guangxi Zhuang Autonomous Region. Through examining institutional aid, professional training programs, collaboration avenues, resources, policy impacts, and other factors, this study offers a quantitative perspective on DQTs' professional development within the given region. The findings contribute to the body of knowledge in three important ways: (1) explaining the relative different factors influencing DQTs' professional development in a culturally broad region, (2) uncovering paradoxical difficulties concerning the literature's assumptions about school-enterprise cooperation, and (3) presenting an empirically based model for assessing DQTs' professional development in the context of regional vocational education systems.

2. Literature review

2.1. Development of double-qualified teachers

The Chinese government supports the development of modern vocational education by increasing the professionalism and practical skills of higher vocational college educators. They are motivated to change and improve their teaching to reform and change teaching in vocational education. Moreover, attempts are being made to develop and enhance the vocational education personnel training standard system. DQTs are of pivotal significance in vocational education, especially so in China, where their enhancement is critical for the advancement of this educational level. The defining characteristic of DQTs is the application of skillful practice to work at performing tasks relevant to the appropriate qualification; hence, they are chiefly in charge of linking academic instruction to practice. The modernization of vocational education proceeds at a different pace depending on the region, territory, or country, but everywhere the construction of DQTs of high quality is equally important (Zhang and Sun, 2022). For these educators, the authors stress the clear need for precise plans of talent recruitment, training by levels, and interdisciplinary teaching.

The merging of theoretical and practical skills is of great importance for equipping students for the workforce, as noted in Wang (2021). DQTs need to have systematic professional knowledge and powerful practical skills so that teaching can be done

in a classroom and a contemporary industry setting. This set of skills helps to ensure that graduates of vocational education are ready to face the demands of their respective industries.

The processes undertaken to develop DQTs include the challenges of professional development and other forms of support. Wang et al. (2023) explained that the robust DQTs workforce development needs institutional frameworks such as policy and financial support. They further argued that for quality vocational education, there has to be a competent professional teaching staff. Fostering DQTs is, as Li and Mao (2021) pointed out, critical for the sustainable growth of higher vocational colleges. This includes providing practical training for educators while ensuring that they follow developments in the relevant fields. Such efforts would guarantee that vocational education programs are relevant and useful. In addition, the assessment of DQTs is equally important for ensuring effectiveness. Zhu et al. (2022) presented a practical assessment approach to improve the frameworks used in evaluating DQTs for the purpose of enhancing this important teaching resource. In essence, the goal of the proposed system is to enable the DQTs to qualify to offer quality vocational education.

2.2. Factors influencing professional development in Guangxi

As Wu (2022) claimed, continuous training ensures that educators remain informed on new developments within their disciplines. For instance, training for DQTs typically consists of workshops, seminars, and other professional training activities designed specifically for vocational educators. As an illustration, a DQT for automotive technology may attend workshops on new technologies for teaching electric vehicles so that they may teach the concepts as well as applicable skills (Liu et al., 2024). Moreover, some seminars can prepare DQTs with the appropriate competencies on teaching with digital media and technology for the purpose of revalidating their instructional approaches as modern and relevant (Haleem et al., 2022). Supplied with updated knowledge and skills, DQTs are able to enhance the curriculum's relevance by ensuring that the instruction meets modern standards, therefore raising the quality and effectiveness of vocational education (Ling et al., 2023).

Support from institutions is crucial for the professional development of DQTs. Financial recognition, professional development policies, and honoring the responsibilities of practitioners are equally important (Booth et al., 2021). Vocational institutions must foster a culture of learning and career advancement by providing access to industry professionals, collaborative research opportunities, profession-related workshops, and other resources. In addition, institutions ought to develop policies that acknowledge and compensate for the special skills of DQTs so that these practitioners are

motivated to engage in continual professional development. School-enterprise cooperation is equally important for DQTs' professional development (Zhang and Wang, 2021). These collaborations enable teachers to acquire practical skills while ensuring their instruction meets current industry standards. For instance, Liuzhou Vocational and Technical College (LVTC) and its partnership with local industries, such as LiuGong and Guangxi Auto, provide DQTs with relevant training and instructional experience to ensure educational curricula are up-to-date and vocational education is improved.

The professional competence of DQTs in Guangxi is impacted by the region's socioeconomic context, which requires trained personnel with appropriate theoretical and practical skills for initiatives like the China-ASEAN Free Trade Area (Xu and Sarino, 2023). Training for educators in cultural competence and inclusive teaching is necessary to address the multifaceted educational challenges posed by the diverse population in Guangxi, which is in sync with system-wide goals of inclusion. Moreover, advanced DQTs possessing sophisticated peripheral resources, such as modern laboratories, teaching aids, professional contacts, and other materials, have a greater opportunity to compete with contemporary practices and pedagogical innovations (Wang et al., 2022). The Guangxi Department of Education's funding for national and international conferences for DQTs helped educators gain exposure to global perspectives and foster the sharing of innovative and advanced teaching ideas, which greatly transformed vocational training approaches and DQTs' effectiveness (Wu and Ye, 2016; Alam, 2022).

Progressive policies assist in the integration of technology into the classroom and foster innovation (Bhaskar and Gupta, 2024). Currently, education reforms in Guangxi focus on implementing digital tools in teaching, which requires ongoing training in IT and digital skills for DQTs (Huang et al., 2024). Such policies ensure that students receive education that is timely and relevant to the emerging technological advancements they will encounter in the workforce (Ahmed et al., 2020; Galanti et al., 2021).

Therefore, based on several scholars' findings, the professional development of DQTs in Guangxi is influenced by an intricate combination of institutional aid, socioeconomic conditions, the level of available resources, and progressive educational policies. By addressing all these aspects, educational institutions in the Guangxi region stand to benefit, as DQTs will be able to provide quality vocational education appropriate to the changing economic and demographic profile of the region.

2.3. Research gaps

Despite significant progress in understanding the professional development of DQTs, several research gaps persist, particularly within the context of the Guangxi Zhuang Autonomous Region. One primary

gap is the lack of empirical studies that comprehensively examine the specific factors influencing the professional growth of DQTs in this region. While the literature has highlighted the importance of continuous training, institutional support, school-enterprise cooperation, and progressive educational policies (Wang et al., 2023; Li and Mao, 2021; Bhaskar and Gupta, 2024), there remains a need for detailed studies that explore how these factors interact and impact DQTs' professional development specifically within Guangxi.

Another notable gap is the limited exploration of how Guangxi's unique socioeconomic context influences DQTs' professional development. The region's diverse cultural landscape and economic initiatives, such as the China-ASEAN Free Trade Area, require a workforce that is proficient in both theoretical and practical skills. However, there is insufficient research on how cultural competence training and inclusive teaching practices can be effectively integrated into professional development programs for DQTs in this region. Understanding these dynamics is crucial given the significant ethnic minority population in Guangxi, which adds complexity to the educational needs and professional requirements of DQTs (Xu and Sarino, 2023).

Moreover, the role of digital literacy and instructional technology in enhancing DQTs' teaching capabilities in Guangxi is underexplored. Despite ongoing reforms aimed at integrating digital tools into the curriculum, there is a paucity of research on how continuous training in digital literacy impacts the effectiveness of DQTs. As highlighted by Huang et al. (2024), integrating digital tools is essential for aligning vocational education with the demands of the modern workforce; however, empirical evidence on the success and challenges of such integrations in Guangxi remains sparse.

2.4. Conceptual framework and hypothesis development

Policymaking, financial support, resource provisioning, and fostering professional growth ecosystems are all constituents of institutional support. It is posited that this support will have a positive effect on the professional development of DQTs within a given framework because resources are provided and opportunities for development are available (Wu, 2022). Workshops, seminars, or professional courses that are specially designed for vocational educators are all aspects of modernized, ongoing training. For educators classified as DQTs, ongoing training is essential in keeping them up to date with current standards so that they can competently teach students and integrate their lessons with demonstrations of real-world scenarios.

School-enterprise cooperation entails the collaboration of a vocational institution with a nearby industry for the provision of hands-on training and exposure for DQTs to the workings of

the industry. Such partnerships are important in ensuring that changes made in vocational education are in alignment with curriculum cuts and relevance in the instruction provided (Zhang and Wang, 2021). Resource availability includes the possession of sophisticated laboratories and other instructional materials alongside professional networks and career development opportunities. All these resources are vital in helping DQTs keep abreast of the current practices and trends in teaching and education (Wu and Ye, 2016).

Progressive educational policies aim at incorporating technology and innovation in the classroom and teaching processes. This includes continuous training in information technology and teaching technology, as well as teaching about

current employment opportunities (Bhaskar and Gupta, 2024; Huang et al., 2024).

On the basis of a review of the literature and the conceptual framework, we propose the following hypotheses, as shown in Fig. 1:

H1: Institutional support positively influences the professional development of DQTs.

H2: Continuous training positively influences the professional development of DQTs.

H3: School–enterprise cooperation positively influences the professional development of DQTs.

H4: Resource availability positively influences the professional development of DQTs.

H5: Progressive educational policies positively influence the professional development of DQTs.

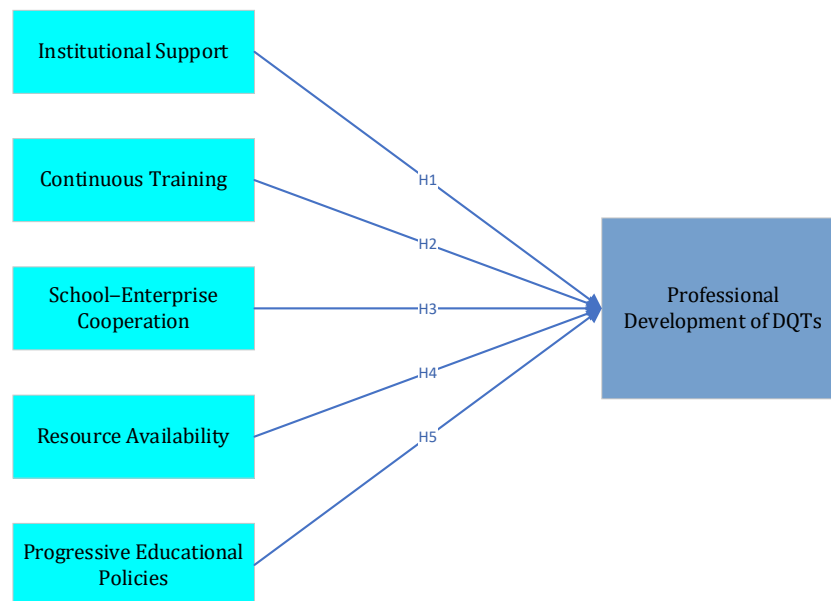


Fig. 1: Hypothesis development

3. Methodology

3.1. Research design

This study has employed a quantitative methodology to examine the professional advancement processes in the Guangxi Zhuang Autonomous Region. The region is noteworthy for its rapid growth in the context of the China-ASEAN Free Trade Area, boasting rich minority cultures. This enriches the context for professional development investigations concerning vocational trainers who work in an increasingly sophisticated educational ecosystem.

Data collection was achieved through configured questionnaires for a sizeable population of DQTs, education administrators, and policymakers within the region. The surveys were constructed with a number of closed questions that aimed at measuring the influence of different factors on DQTs' professional development. The examined constructs included institutional backing for development, continuous training, cooperation with industries, availability of resources, and modern educational policies.

The collected quantitative data will first be processed using statistical packages, which will be used to establish relationships and trends within the data. Among the primary features of the data, descriptive statistics provide an overview of the information, while inferential statistics, including regression analysis, validate and assess the proposed relationships hypothesized among the studied variables.

3.2. Participants and sample size

The sample of this study consisted of DQTs, educational administrators, and policymakers from Guangxi Zhuang Autonomous Region. These groups are selected because they capture all the angles that are concerned with the professional growth of DQTs, such as the teaching personnel, the managers of the educational institutions, and the policy makers and implementers. DQTs are selected because of their unique combination of a theoretical and practical background, which makes them fundamentally instrumental in authenticating the applicability of learning in the classroom to the field. Gaining these perspectives is vital in examining the scope of

professional development, as well as the gaps that DQTs face at tertiary levels. Vocational and college-level educational administrators have invaluable insights that shape and manage professional development programs, which provide a valuable understanding of DQTs' professional development. Policymakers design and implement regional and national educational policies, which serve DQTs' professional development as a broader scope of policy environment and policy initiatives to enhance the professional growth of DQTs.

The approach to determining the sample size for this study was conducted using a statistical power analysis approach, which ensures the sample chosen is representative of the entire population in terms of significance. As noted by [Krejcie and Morgan \(1970\)](#), for a population of 1,000,000, a 95% confidence level with a 5% margin of error prescribes a sample size of 384. With the number of educators, administrators, and policymakers in Guangxi, the sample size is set at 400 to ensure accuracy and validity of the results. The sample population consisted of 250 double-qualified teachers, 100 educational administrators, and 50 policymakers.

The participants are chosen using stratified random sampling to facilitate proper inclusion of every subgroup in the sample. This method ensures a more accurate representation of the research population, which improves the reliability of the research outcomes.

3.3. Questionnaire design

In designing the items of the questionnaire, literature and instruments from prior studies were incorporated, which enhanced the reliability and relevance of the items. Each construct is measured with at least three items to ensure adequate representation. The validity and relevance of the study were achieved by using previous studies in formulating the questionnaire items.

The questionnaire is divided into various parts, each capturing a distinct dimension of DQTs' professional development. The first part captures

demographic data: Age, sex, educational qualifications, and current position.

Institutional support is the focus of the second section. This portion examines the extent to which educational institutions offer support, including policy support, funding, and appropriate materials. This section is based on previous work done by [Philipsen et al. \(2022\)](#) and therefore has relevance and validation. These items measure the degree of support that is available to DQTs for enhanced professional development. Furthermore, the third section measures the degree of instruction given through the availability and adequacy of training, workshops, seminars, and other professional courses. Items from [Leendertz et al. \(2015\)](#) were used, highlighting the significance of sustaining training in the development of DQTs.

The Fourth Section looks at school-enterprise cooperation, which is the cooperation of vocational schools with local industries. The items are adapted from [Haisheng et al. \(2016\)](#), who assessed how these collaborations offered practical training opportunities for DQTs. The fifth section evaluates resource availability, measuring the adequacy of physical resources like laboratories, teaching aids, and mentors in professional networking. The items in this section are adapted from [Ayyoobi et al. \(2016\)](#) and [Wu and Ye \(2016\)](#), who talked about the role of resources in professional development.

The sixth section assesses advanced educational policies and considers the effect of policies that foster the integration of innovation and technology into the teaching curriculum. These items are adapted from [McChesney and Aldridge \(2018\)](#) concerning the influence of educational policies on the professional development of educators.

Last, the seventh section evaluates the overall professional development of DQTs in terms of theoretical and practical teaching skills, teaching skills, and effectiveness. The items in this section are adopted from [McChesney and Aldridge \(2018\)](#) to ensure that the items are credible and grounded.

The detailed parts of the questionnaire mentioned above can be found in [Table 1](#).

Table 1: Questionnaire framework and contents

Section	Items	Reference
Demographic information	Age, gender, educational background, years of teaching experience, and current position	—
Institutional support (IS)	1. My institution provides adequate financial support for professional development. 2. There are clear policies in place that support my professional growth.	Philipsen et al. (2022)
Continuous training (CT)	3. I receive administrative support for attending professional development programs. 1. I have access to regular workshops that enhance my teaching skills. 2. The training programs I attend are relevant to my teaching needs.	Leendertz et al. (2015)
School-enterprise cooperation (SEC)	3. Continuous training programs provided by my institution are of high quality. 1. My institution collaborates with local industries to provide practical training opportunities. 2. The school-enterprise partnerships enhance my practical teaching skills.	Haisheng et al. (2016)
Resource availability (RA)	3. I have participated in industry-led training programs organized by my school. 1. I have access to the necessary teaching materials to effectively perform my job. 2. There are sufficient resources available for my professional development.	Ayyoobi et al. (2016) and Wu and Ye (2016)
Progressive educational policies (PEP)	3. The facilities provided by my institution are adequate for my teaching needs. 1. The educational policies in place encourage the use of digital tools in teaching. 2. Policies that support innovative teaching methods.	McChesney and Aldridge (2018)
Professional development of DQTs (PDD)	3. Educational reforms in my institution promote the integration of technology into teaching. 1. I feel that my professional development has significantly improved my teaching effectiveness. 2. The professional development programs I participate in are effective in enhancing my skills. 3. I am satisfied with the professional development opportunities available to me.	McChesney and Aldridge (2018)

3.4. Data collection methods and procedure

This study's data collection design uses a systematic survey approach, conducting the questionnaire on an online platform, Wenjuanxing (www.wjx.cn). This platform is among the popular online survey services in China because it helps easily and effectively gather information from numerous respondents. This platform is particularly helpful for engaging participants from the Guangxi Zhuang Autonomous Region so that the sample is inclusive and diverse. The survey is directed towards DQTs, educational administrators, and policy formulators within the region. The structured questionnaire, which was developed based on an empirical literature review, is sent through Wenjuanxing to the different respondents in the target area. The use of Wenjuanxing helps to gather information from fragmented regions since participants who are far apart can be reached easily.

The target participants were sent, through email and social media, the invitation to participate in the survey, which contained the link to Wenjuanxing. Such an approach increases ease of submission and encourages participation. The survey is designed with detailed guidelines that enable participants to know what is required of them in every part of the survey and respond accurately.

In order to improve the dependability of the data gathered, participants who have not completed the survey within a certain period of time are sent multiple reminders. This technique increases the response rate and validity by making certain that the data gathered is representative of that particular group. Table 2 demonstrates the steps for the data collection procedure.

3.5. Data analysis methods

The measurement reliability and validity checks were carried out using SmartPLS 4 to ensure that the constructs had indeed been measured correctly and consistently. Reliability is measured through Cronbach's alpha, which is based on internal consistency. Generally, it is accepted that a

Cronbach's alpha value of 0.70 or higher is indicative of each item within the respective construct measuring the same underlying concept consistently (Nunnally and Bernstein, 1994). Convergent validity checks the average variance extracted (AVE) for a construct, where a value greater than or equal to 0.50 is considered adequate convergence (Fornell and Larcker, 1981). Discriminant validity checks if the square root of the AVE for each construct genuinely diverges from the correlation between the constructs, ensuring that each is distinct from the other (Fornell and Larcker, 1981).

Applying the SmartPLS 4 software, SEM was performed to test the posited interconnections among the variables. SEM is an advanced statistical method that integrates observing the interaction of various factors (both measurable and non-measurable) within a system. It synthesizes factor analysis with multiple regression analysis, which allows for direct and indirect evaluations to be made within the model (Hair et al., 2010).

4. Results

4.1. Demographic information

The sample comprises a balanced mix of genders across different age groups, with a relatively greater proportion of female participants across most age groups, except for the oldest age group, where the gender ratio is balanced (Table 3). Specifically, among the age groups, the 25–29 and 55–59 age brackets presented the highest female representation, at 60.7% and 68.0%, respectively. The educational qualifications of the participants reveal that the majority hold a master's degree (55.9% female and 44.1% male), followed by a bachelor's degree (60.7% female and 39.3% male), with PhD holders and those with other qualifications forming smaller groups. The distribution of current positions shows that the majority of participants are DQT (55.7% females and 44.3% males), followed by educational administrators (63.3% females and 36.7% males) and policymakers (60.7% females and 39.3% males).

Table 2: Data collection procedure steps

Step	Description
Preparation	Develop a questionnaire based on validated items from the literature and set it up on Wenjuanxing.
Distribution	Distribute the survey link via email and social media platforms to the target participants (DQTs, educational administrators, and policymakers).
Data collection	Monitor survey responses on Wenjuanxing. send reminders to participants who have not completed the survey within the specified timeframe.
Follow-up	Conduct follow-up communications with participants as needed to clarify any ambiguous responses and encourage completion of the survey.
Data management	Download the data from Wenjuanxing, ensuring secure storage and anonymization to maintain the confidentiality and privacy of the participants.
Preliminary analysis	Use the tools provided by Wenjuanxing for initial data cleaning and analysis to prepare the data for more detailed statistical analysis.

4.2. Construct reliability and validity

Upon examining the literature in the references, we found that there are multiple elements that can impact the professional development of DQTs. The results of the reliability and validity tests in Table 4

demonstrate the robustness of the measurement constructs used in this study among the variables. Most of the constructs exhibit good to excellent internal consistency, as indicated by the Cronbach's alpha values, with continuous training at 0.778, professional development of DQTs at 0.850, resource

availability at 0.885, and school and enterprise cooperation at 0.873. Progressive educational policies, with a Cronbach's alpha of 0.680, while lower, remain acceptable in exploratory research contexts, as this value exceeds the 0.60 threshold often applied in early-stage research (Hair et al., 2010). Similarly, institutional support, at 0.605, meets the minimum threshold criteria for exploratory studies, although researchers acknowledge this as an area for conceptual refinement in future research. Validity is confirmed through composite reliability and AVE values, all of which meet or exceed the accepted thresholds. For example, continuous training has a composite reliability (rho_c) of 0.871 and an AVE of 0.692, the professional development of DQTs has a rho_c of 0.909 and an AVE of 0.769, and both resource availability and school and enterprise cooperation

demonstrate high validity, with AVE values of 0.813 and 0.797, respectively. Despite institutional support showing moderate composite reliability with a rho_c of 0.751 and an AVE of 0.511, overall, the constructs used in this study are robust, providing a strong foundation for analyzing the factors influencing the professional development of DQTs in Guangxi. These findings confirm that the data collected are reliable and valid, ensuring the integrity of the conclusions of the study. While some constructs have lower internal consistency values, they remain within acceptable thresholds for exploratory research (Taber, 2018). The researchers addressed potential limitations by ensuring that composite reliability values for these constructs (institutional support: 0.751; progressive educational policies: 0.823) exceeded the more stringent 0.70 threshold, thereby supporting the overall measurement model's validity.

Table 3: Demographic summary

Category	Options	Gender		Total
		Female	Male	
Age	25-29	34(60.7%)	22(39.3%)	56
	30-34	35(59.3%)	24(40.7%)	59
	35-39	34(68.0%)	16(32.0%)	50
	40-44	24(60.0%)	16(40.0%)	40
	45-49	30(52.6%)	27(47.4%)	57
	50-54	32(51.6%)	30(48.4%)	62
	55-59	34(68.0%)	16(32.0%)	50
	60 and above	32(50.0%)	32(50.0%)	64
Educational background	Bachelor	91(60.7%)	59(39.3%)	150
	Master	114(55.9%)	90(44.1%)	204
	PhD	45(59.2%)	31(40.8%)	76
	Other	5(62.5%)	3(37.5%)	8
Current position	DQT	152(55.7%)	121(44.3%)	273
	Educational administrator	69(63.3%)	40(36.7%)	109
	Polycymaker	34(60.7%)	22(39.3%)	56

Table 4: Reliability and validity overview

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	AVE
Continuous training	0.778	0.784	0.871	0.692
Institutional support	0.605	0.745	0.751	0.511
Professional development of DQTs	0.850	0.852	0.909	0.769
Progressive educational policies	0.680	0.737	0.823	0.613
Resource availability	0.885	0.885	0.929	0.813
School-enterprise cooperation	0.873	0.875	0.922	0.797

4.3. Path coefficients

As shown in Table 5, the path coefficients indicate the strength and direction of these relationships, helping to understand which factors most significantly impact the professional development of DQTs. Continuous training has a positive path coefficient of 0.166, suggesting that regular training programs enhance the professional development of DQTs. Institutional Support, with a path coefficient of 0.093, shows a positive but weaker influence, indicating that policy backing and resource allocation, while beneficial, might not be as impactful as other factors. Progressive educational policies, with a path coefficient of 0.144, highlight the importance of policies promoting innovation and technological integration in enhancing DQTs' professional development. The most substantial positive influence comes from resource availability, which has a path coefficient of 0.545, underscoring the critical role of providing adequate resources such as laboratories, teaching materials, and access

to professional networks. Interestingly, School-enterprise cooperation has a negative path coefficient of -0.034, suggesting that current collaborations between schools and industries might not effectively contribute to the professional development of DQTs, possibly due to misalignments or inefficiencies in these partnerships. These findings highlight the need for focused improvements in school-enterprise cooperation and reinforce the importance of continuous training, resource availability, and progressive educational policies in fostering the professional growth of DQTs in Guangxi.

As shown in Table 6, the outer loadings measure the correlation between each item and its respective constructs, with values closer to 1 indicating higher reliability.

For the continuous training construct, the outer loadings for CT-1, CT-2, and CT-3 are 0.809, 0.856, and 0.830, respectively. These high loadings suggest that these items are strong indicators of the continuous training construct. In the case of

Institutional Support, the outer loadings for IS-1, IS-2, and IS-3 are 0.871, 0.695, and 0.539, respectively. While IS-1 shows a high loading, IS-2 and IS-3 exhibit lower loadings, particularly IS-3, which indicates potential issues with this item's reliability and suggests the need for refinement or reconsideration of this item.

For the professional development of DQTs, the outer loadings for PDD-1, PDD-2, and PDD-3 are 0.865, 0.878, and 0.887, respectively. These values indicate that all three items are strong and reliable measures of this construct. Moreover, progressive educational policies are measured by PEP-1, PEP-2, and PEP-3, with outer loadings of 0.860, 0.857, and 0.605, respectively. While PEP-3 shows a comparatively lower loading, it remains above the 0.60 threshold considered acceptable, and its retention is justified by theoretical considerations regarding the comprehensive measurement of educational policy impacts.

Resource availability is assessed through RA-1, RA-2, and RA-3, all of which have very high outer loadings of 0.901, 0.901, and 0.902, respectively. These consistent and high values reflect the strong reliability of these items in measuring the resource availability construct.

Table 5: Path coefficients summary

X→Y	Path coefficients
Continuous training → professional development of DQTs	0.166
Institutional support → professional development of DQTs	0.093
Progressive educational policies → professional development of DQTs	0.144
Resource availability → professional development of DQTs	0.545
School-enterprise cooperation → professional development of DQTs	-0.034

Finally, for School-enterprise cooperation, the outer loadings for SEC-1, SEC-2, and SEC-3 are 0.865, 0.914, and 0.899, respectively. These high loadings indicate that these items are robust indicators of the school-enterprise cooperation construct.

Overall, most items across the constructs show strong outer loadings, indicating good reliability and validity. However, certain items within Institutional Support (IS-2 and IS-3) and Progressive Educational Policies (PEP-3) exhibit lower loadings, suggesting areas for potential improvement. This detailed analysis supports the robustness of the measurement model while also highlighting specific items that may need further refinement to enhance overall reliability and validity.

5. Discussion

The results of this study are pivotal for understanding the professional development of DQTs in the Guangxi Zhuang Autonomous Region. SEM analysis revealed several critical relationships among the examined variables.

The demographic analysis revealed that the sample of participants across the range of ages, levels of education, and current employment was

fairly inclusive, with the majority being women. This diversity enhances the generalizability of findings across different segments of DQTs in Guangxi. Most constructs in the study demonstrated good reliability and validity, although some items related to institutional support and progressive educational policies had suboptimal reliability.

Table 6: Outer loadings

Item code	Construct	Outer loadings
CT-1	Continuous training	0.809
CT-2		0.856
CT-3		0.830
IS-1	Institutional support	0.871
IS-2		0.695
IS-3		0.539
PDD-1	Professional development of DQTs	0.865
PDD-2		0.878
PDD-3		0.887
PEP-1	Progressive educational policies	0.860
PEP-2		0.857
PEP-3		0.605
RA-1	Resource availability	0.901
RA-2		0.901
RA-3		0.902
SEC-1	School-enterprise cooperation	0.865
SEC-2		0.914
SEC-3		0.899

As hypothesized, resource availability was found to be the most significant factor impacting DQTs' professional development, with a path coefficient of 0.545. This finding demonstrates the vital need for physical and professional resources such as advanced laboratories and teaching materials, as well as professional network access. These outcomes support the body of literature that underscores the importance of available resources for the quality of vocational education (Wu and Ye, 2016).

Continuous training had a notable positive effect as well (path coefficient of 0.166), confirming that ongoing training is vital to updating educators within their disciplines. This finding reaffirms earlier studies highlighting the gap in addressing the integration of professional practice and theoretical knowledge through continuous professional development (Wu, 2022).

Progressive educational policies also had a positive impact, with a path coefficient of 0.144, reinforcing the need for innovative technology inclusion policies within curriculum frameworks as essential for the modernization of vocational education (Bhaskar and Gupta, 2024; Huang et al., 2024). Support from the institution was positive but had the weakest influence of 0.093. This implies that although policy support and the allocation of resources may help, there is limited impact relative to direct resources and training programs. These findings contradict Philipsen et al. (2022) and Booth et al. (2021), who identified institutional support as a key propeller of professional development within other educational settings. This contrast is likely due to the level of development of vocational education in Guangxi, highlighting the role of the region in shaping the way such support factors professional development.

Interestingly, school-enterprise cooperation had a negative path coefficient of -0.034, which indicates

that the contemporary relationship between schools and industries does not aid in the advancement of DQTs' professional development. This is contrary to how such partnerships are expected to yield positive results and indicates that some inefficiencies or gaps exist that need to be addressed. Other authors have noted the value of school-enterprise cooperation (Zhang and Wang, 2021), but these findings suggest that the particular context in Guangxi might require rethinking and refinement. The unanticipated adverse correlation could be due to the partnerships' burdening DQTs with extra responsibilities and insufficient supporting resources, or with gaps in provided educational objectives and the actual needs of the industry, which is particularly demanding given Guangxi's rich ethnic and economic diversity.

The surprising inverse correlation between school-enterprise cooperation and DQTs' professional development requires further exploration. We explain this with some of Guangxi's unique particularities. First, some existing partnerships may actually augment the burden of work assigned to DQTs without commensurate professional rewards, thus undermining development opportunities instead of accentuating them. Second, the gaps between education goals and industry goals might result in placing DQTs in contested, competing gaps, which is especially difficult in Guangxi's multiethnic and multieconomically diverse region (Grey, 2019). Third, it seems more important how these collaborations are implemented than whether they exist at all—these partnerships, which do not involve systematic exchanges of professional knowledge or effective means of interaction, may hamper growth instead of fostering it. This contradicts the common understanding concerning the relationships between schools and enterprises, emphasizing that the regional context and implementation quality of initiatives are crucial.

These findings are important for both theory and practice for educational stakeholders in Guangxi. For policymakers, the results indicate the need to shift towards teaching resources and infrastructure development before expanding any policy frameworks. The study suggests the creation of regional resource centers for specialized equipment sharing and the formulation of policies with specified resource allocation stipulations. Policies should provide for specific resource allocation stipulations, as resources must be explicitly defined. Focused continuous training courses should be offered for industry-specific practical skills, along with mentoring schemes for more experienced DQTs for junior teachers.

Vocational institutions may wish to revise their school-enterprise cooperation models to include specific guidelines for the partition of tasks and remuneration, appoint staff specifically to coordinate partnership relations, and develop joint evaluation frameworks that uphold academic standards while acknowledging the influence of industry stakeholders.

6. Conclusion

The positive influence that resource availability has indicates the importance of having adequate physical and professional resources in vocational education. The trainers' continuous training paradigm proves that further professional development courses are necessary to enable educators to be active and effective. Informational and technological integration is also innovatively embraced by modern educational practices, which shows that progressive educational policies do wonders as well.

The impact of policy and administrative support is less significant, which suggests current structures are lacking. The inefficiency of the partnership between school and enterprise implies that these unrelated business activities hamper rather than further professional preparation for DQTs, requiring substantial refinement.

Addressing the study's hypotheses, it was found that having physical and professional resources alongside continuous training and progressive educational policies enhances DQTs' professional development. The weaker benefit provided by institutional support and the negative consequence from school-enterprise cooperation, however, suggests more focus on these areas.

List of abbreviations

ASEAN	Association of Southeast Asian Nations
AVE	Average variance extracted
CT	Continuous training
DQTs	Double-qualified teachers
IS	Institutional support
LVTC	Liuzhou vocational and technical college
PDD	Professional development of double-qualified teachers
PEP	Progressive educational policies
PLS	Partial least squares
RA	Resource availability
SEC	School-enterprise cooperation
SEM	Structural equation modeling

Compliance with ethical standards

Ethical considerations

All participants provided informed consent prior to their participation in the study, and their responses were collected anonymously to ensure confidentiality.

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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