

# Guidelines for Development of 21st Century Digital Skills for University Teachers in Guangxi, China

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## Abstract

This study aimed to develop guidelines for the development of 21st-century digital skills for university teachers in Guangxi, China, providing specific and practical references for improving their digital skills and promoting their teaching practices to adapt to the requirements of the digital age. The study was divided into three stages: First, investigate the current situation. The sample for this stage included 380 teachers from 22 universities in Guangxi. The research instrument was a Likert five-point scale questionnaire created by the researcher, with a reliability score of 0.925. The statistical methods used for data analysis included frequency, percentage, mean, and standard deviation. Secondly, develop development guidelines, select 10 teachers who won awards in the Guangxi Higher Education Teaching Informatization Competition, and select 7 experts for semi-structured interviews and data analysis. Finally, evaluate the guidelines and the handbook by 30 qualified experts in the fields of big data and artificial intelligence (AI). The 5-level rating scale was also used to collect data, and the mean and standard deviation were statistically analyzed. It was found that: 1) The current status of 21st-century digital skills for university teachers in Guangxi was at a high level overall and in each aspect. 2) The guidelines for development of 21st-century digital skills for university teachers in Guangxi required development in six areas: teaching ability, learner ability, innovative thinking and problem-solving, professional development ability, digital technology ability, and digital safety. 3) The evaluation results indicated that the guidelines and the handbook for developing 21st-century digital skills for university teachers in Guangxi had reached the highest level in terms of feasibility and utility.

**Keywords:** 21st century digital skills; University teachers; Development guidelines; Current situation analysis; Feasibility and utility evaluation

## Introduction

The world today is undergoing major changes unseen in a century, and the new technological revolution and industrial transformation are the key variables in these major changes. The mobility and ubiquity of network interconnection, along with high-speed and intelligent information processing, will facilitate the integrated development of digital technology across all industrial factors, the entire industrial chain, and the complete value chain, ultimately driving the comprehensive digitization of human production and lifestyle (Wang, 2022). The development of digital education is an important part of bridging the digital divide and building a digital China. In 2022, the report of the 20th National Congress of the Communist Party of China for the first time stipulated that education, technology and talents should be “three-in-one” and integrated management and application, and for the first time included “promoting digital education” in the report (Huai, 2022). In the same year, the Ministry of Education officially launched the Strategic Action on Digital Education.

Mr. Xia Zehan, Representative of UNESCO Office in China, pointed out, only by continuously improving teaching skills, updating teaching methods and improving digital literacy can teachers realize the transformation into a digital economy (Feng et al., 2023). However, China is in a critical period of transformation, where the level of educational data is still improving, and new digital intelligence technologies such as big data analysis and artificial intelligence are forcing the transformation of educational concepts, models and innovations of educational content and methods (Wang et al., 2023). On the one hand, the integration of digital technology with education is gradually deepening, and teachers need to adapt to the intensive development of digital technology and the rapid development of the education industry (Hang & Chayanuvat, 2024). The implementation of major policies such as the reform of educational evaluation has increased the demand for teachers’ digital literacy (Kanthapong et al., 2025). However, teachers in China have not paid enough attention to digital teaching concepts and digital teaching innovation capabilities (Wu et al., 2023).

This research addresses practical challenges faced by university teachers in digital transformation, aiming to provide structured guidance. Researchers hope to solve the practical problems encountered by frontline university teachers in digital transformation through research, and construct corresponding theories to enrich the achievements of digital skills development for university teachers, improve their 21st century digital skills, and promote the strategic requirements of digitalization in higher education.

## Research Objectives

1. Investigate the current status of 21st century digital skills for university teachers in Guangxi, China.
2. Develop guidelines for development of 21st century digital skills for university teachers in Guangxi, China.
3. Evaluate the feasibility and utility of the guidelines and the handbook for development of 21st century digital skills for university teachers in Guangxi, China.

## Literature Review

This section reviews literature on the research findings on teachers' 21st century digital technology skills at home and abroad, focusing on teaching ability, learner ability, innovative thinking and problem-solving, professional development ability, digital technology ability, digital safety. Additionally, it highlights studies concerning the interactions among these variables.

EU. (2017) divides educators' digital competence into six areas: professional participation, digital resources, teaching and learning, evaluation, empowering learners, and helping learners develop digital competence.

Rubach and Lazarides (2021) analyzed and identified six dimensions of teachers' basic ICT competency beliefs: information and data literacy, communication and collaboration, digital content creation, safety and security, problem solving, and analysis and reflection.

Dan et al. (2022) pointed out that the concept of constructing a digital literacy framework for teachers in China emphasizes comprehensively improving teachers' information technology application capabilities, promoting the deep integration of information technology and education and teaching, meeting learners' intelligent learning requirements, and improving teachers' professional development level. In the context of following the iteration of technological development, it emphasizes promoting the transformation of teachers' roles and innovation of teaching methods.

UNESCO. (2011) suggests that it is not enough for teachers to be ICT-savvy and able to teach students about ICT. Teachers need to be able to help students become collaborative, problem-solving, creative learners through the use of ICT so that they can become effective citizens and members of the workforce.

Ge et al. (2017) pointed out that teachers should be use an innovation that integrates technology and teaching, which is to reorganize the learning environment with technology and provide effective teaching strategies to promote classroom teaching effectiveness, thereby developing learners' autonomous learning ability, problem-solving ability, critical thinking and creative work ability.

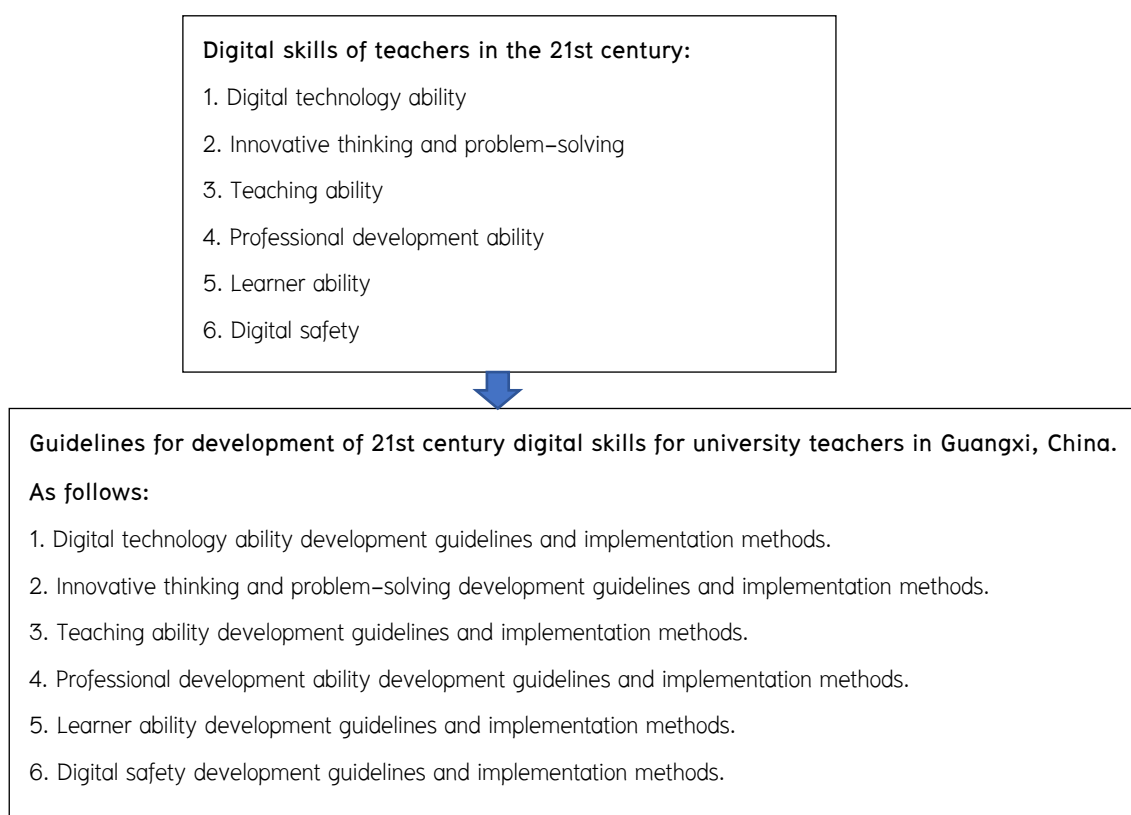
Kong et al. (2023) proposed that university should focus on teachers' access to information technology infrastructure and their appropriate use of information technology, hoping to help improve teachers' digital literacy and safeguard students' digital literacy development, thus bridging the digital divide.

Wu et al. (2023) In the 21st century, teachers' digital capabilities have changed from focusing on the development of teachers' own digital capabilities to focusing on promoting the development of students' digital capabilities, and from focusing on digital technology and tools themselves to focusing on the educational functions of digital technology and tools.

Scholars have conducted in-depth discussions on the development of teachers' digital skills from different perspectives such as competency framework, teaching innovation, student development, and technical support, revealing its characteristics and trends, and providing a new perspective for teachers' professional development. In particular, the study of digital skills of university teachers shows the influence of deep integration of information technology and higher education in teachers' role transformation, which lays a solid foundation for the deepening and expansion of this study.

## Conceptual Framework

The researchers determined the research framework based on information from review of relevant domestic and international studies and other concepts, reports, articles, and databases. The researchers studied the digital skills of teachers in the 21st century in universities in Guangxi Province. Based on the scholars' ideas, papers and related research works of (Li & wang, 2022; European Commission, 2017; UNESCO, 2011; Dan. et al, 2022; Huang, 2020; Lan et al 2021; Liu & Re, 2023; Kong & Wang, 2023; Yan & Liu, 2022; Wu & Xue, 2023, and Rubach & Lazarides, 2021) have synthesized digital skills for teachers in the 21st century. The framework of this study is shown in Figure 1.



**Figure 1** Conceptual framework of guidelines for development of 21st century digital skills for university teachers in Guangxi, China.

## Research Methodology

The researcher has studied documents and related research to be used as guidelines for the research, as detailed below:

**Phase 1:** Investigate the current status of 21st century digital skills for university teachers in Guangxi, China.

### 1. Population and sample

Population: The population consists of teachers at 38 universities in Guangxi.

Sample: Randomly select at least 50% of universities from all cities in Guangxi, totaling 22 universities and 34,416 teachers. The sample size used in the study was determined from the ready-made table by Krejcie and Morgan. The sample size was 380 people were selected.

### 2. Research Tools

The research tool was questionnaire survey, which was divided into two parts.

Part 1: General information of the respondents, data collected through a checklist questionnaire.

Part 2: To study the current situation of educational management of private vocational college in Jiangxi vocational university, People's Republic of China, using five-level scale questionnaire to collect data. Cronbach Alpha test and item objective congruence index (IOC) were used to test the reliability of the questionnaire. The results showed that the Cronbach  $\alpha$  coefficient of the questionnaire showed a high internal consistency of 0.925. Therefore, it is considered a reliable tool.

**Phase 2:** Develop guidelines for development of 21st century digital skills for university teachers in Guangxi, China.

The data obtained from the processing in Phase 1 were analyzed and synthesized to study the factors affecting digital skills of teachers in the 21st century.

Target group: There were a total of 17 people, obtained by purposive sampling.

Teachers who received awards from the competition in information studies at the higher education level in Guangxi, 10 people. Experts: 7 people.

The research tool for this stage is the semi-structured interview created by the researcher. The interview script is created by combining the data from the first stage, and the interview outline is created by taking the 3 questionnaire questions that the respondents answered the most.

**Phase 3:** Evaluate the feasibility and utility of the guidelines and the handbook for development of 21st century digital skills for university teachers in Guangxi, China.

The data obtained from the processing of the second phase were analyzed and synthesized to study the feasibility and utility of the 21st century digital skills development guidelines for undergraduate teachers, as follows:

Target group: 30 experts who are qualified as heads of the field of big data and artificial intelligence, using the purposive sample method.

Data collection tools: The data collection tools were a form to evaluate the feasibility and utility of the 21st century digital skills development guidelines for teachers.

## Research Results

### Guidelines for development of 21st century digital skills for university teachers in Guangxi, China

#### 1. Teaching ability development guidelines and implementation methods.

1.1 Encourage teachers to produce short video media and online video media for use in teaching.

(1) Executives promote the project-based cooperation model and develop a ‘two-way evaluation’ mechanism by pairing new teachers with senior teachers to exchange knowledge, communicate, and work together to develop video editing capabilities through parallel mentoring.

(2) The head of the research department for teaching management develops a learning community by inviting media experts or selecting teachers with expertise in video editing as speakers to share editing skills. At the same time, develop a cloud resource repository and establish a mechanism for exchanging equipment using a cumulative score system.

(3) Teachers can develop themselves by using their free time to self-study from quality learning resources on video editing techniques on online video platforms such as TikTok and Bilibili or by participating in online workshops organized by social media influencers (KOLs) organized by executives.

1.2 Encourage teachers to use online platforms to publish learning media, organize teaching schedules, manage and analyze student learning outcomes, and after-school tasks Measurement and evaluation, etc.

(1) Administrators must determine that online learning platform usage skills are part of the orientation training for teachers, and continuously develop training mechanisms based on teachers’ expertise levels and assessment of their abilities.

(2) Administrators encourage teachers to apply and develop online learning platform usage skills through reward mechanisms, so that they understand the characteristics and principles of online learning management and achieve the objectives of developing teaching and learning outcomes.

(3) Administrators should seriously promote the integration of digital technology within the university, reduce the limitations of the connection between online learning management platforms and university management systems, and develop an integrated digital education environment.

1.3 Encourage teachers to apply presentation programs (e.g. PPT, Word, WPS) to design and create presentation media.

(1) Administrators organize a competition for presentation design and creation skills by developing a competition platform and dissemination of results, improving the reward mechanism for the competition, and encouraging teachers to research and develop the production and design of presentation media.

(2) Administrators open classes to enhance presentation media creation skills and organize training according to the level of expertise, so that teachers have individual learning channels.

(3) The university unit or subject group, the head of the subject group, determines the standard for producing presentation media for unified teaching and learning management, and develops a resource repository on the cloud system. and establish a mechanism for updating standards to be up-to-date.

(4) Teachers collect suggestions from students' teaching management to gain a deeper understanding of the learning experiences and needs of students, making the content of the media more specific, more interesting, and better supporting classroom teaching management.

## 2. Learner ability development guidelines and implementation methods.

2.1 Encourage teachers to apply various digital tools and provide a variety of learning resources so that learners can learn most effectively.

(1) School administrators introduce a high-quality online teaching platform, which not only provides a variety of teaching resources covering all subjects, all levels and various types for teachers to select and share, but also enhances the tiered authorization function by providing a relatively private and shared space between teachers and students to facilitate teachers to share specific resources and allow students to access content that matches their learning progress safely and on target.

(2) School administrators assign tasks to upload online learning resources, requiring teachers to provide relevant learning resources and provide standard template tools and establish a dedicated technical support team to help teachers upload resources efficiently.

2.2 Encourage teachers to apply digital technology resources to analyze learners' learning differences and provide personalized advice.

(1) Administrators introduce a high-quality online learning management platform with powerful data analysis and interaction functions to provide a physical foundation for teachers to

apply digital technology resources to analyze learners' learning differences and provide personalized advice.

(2) Administrators use strategies “Study tours and invitations to experts” by organizing lecturers to travel for study tours and inviting lecturers and experts from outside the university to give lectures, workshops, or demonstrate learning management to learn from modern practices and successful experiences of other universities in applying digital technology resources to analyze differences in student learning and provide personalized advice.

2.3 Encourage lecturers to recommend learners to apply information technology in learning, research, and seeking knowledge outside the classroom.

(1) Executives assign the mission of “ideological study in the curriculum” by integrating the application of information technology with ideological study in the curriculum in depth and developing a cross-curriculum case study repository and quantitative assessment system to guide lecturers to convey the advantages and importance of information technology to learners and promote learners' interest and potential in using information technology to explore unknown boundaries by themselves.

(2) Executives organize topic sharing lectures by inviting lecturers with expertise within the university who recommend learners to apply information technology in learning to share their experiences and establish an inter-university learning management research community continuously to promote the accumulation and sharing of experiences.

3. Innovative thinking and problem-solving development guidelines and implementation methods.

3.1 Promote teachers to be aware of digital innovation and creativity.

(1) Executives should collaborate in depth with technology enterprises, such as inviting enterprises to showcase digital educational technology, jointly develop curricula, conduct joint research projects, and establish ‘educational technology innovation laboratories’, including inviting consultants from enterprises to provide advice in universities.

(2) Executives should focus on setting effective incentive policies to promote digital innovation teaching for teachers and continuously monitor and evaluate the implementation of the policies.

(3) Executives should support teachers to establish interdisciplinary teaching research groups regularly to promote cooperation between teachers from various learning areas and conduct interdisciplinary digital innovation teaching projects.

(4) Executives can promote teachers' knowledge seeking by setting diverse incentive policies, encouraging teachers to actively participate in interdisciplinary and cross-learning learning and training courses to develop diverse knowledge and effectively promote digital creativity.

(5) Teachers can develop their potential in digital innovation and creativity through participation in action projects and competitions in the exploration and problem-solving process, with executives providing structural support. To promote development and innovation.

3.2 Encourage teachers to use new concepts such as “Flipped Classroom”, “MOOC”, “Micro-Course” in teaching.

(1) Executives seriously apply learning management innovations and organize individual training in a blended format, both online and offline, so that teachers can understand and apply them naturally.

(2) Executives encourage teachers to participate in related competitions by developing a special reward system and promoting practice in using modern learning management equipment through competitions.

(3) Executives arrange for teachers to study and exchange knowledge outside the university to learn and observe advanced learning management experiences of other universities or regions in using modern learning management equipment. After the study visit, organize a learning exchange meeting within the university and collect data to compile documents for dissemination so that teachers can benefit more.

(4) The faculty working group jointly develops a learning management plan using communication and cooperation of the working group to jointly develop teachers' potential in using modern learning management equipment. At the same time, external evaluation mechanisms are used and a learning management plan development resource library is developed for learning exchange.

3.3 Encourage teachers to apply digital technology to solve students' learning management problems effectively.

(1) Executives set standards and develop related systems. By specifying that lecturers apply digital technology to solve problems in managing student learning and proceed according to their level of expertise.

(2) Executives organize learning exchange activities within the university or between universities regularly, focusing on specific issues of digital technology application, inviting experienced and successful speakers to give special lectures, and organizing group discussions to

encourage lecturers to study techniques of applying digital technology in managing student learning and experiment with digital technology innovations.

(3) Executives organize teaching and demonstrations of excellent digital technology application within the university regularly, select classrooms of lecturers with specific characteristics and good results in using digital technology in managing student learning, arrange for other lecturers to observe and learn at the actual location, and promote practical application through reward mechanisms.

#### 4. Professional development ability development guidelines and implementation methods.

4.1 Encourage lecturers to apply various techniques, methods and strategies to develop their professional research potential.

(1) Executives regularly arrange for lecturers to attend external training courses and strengthen training efficiency management by developing a reasonable and scientific training efficiency evaluation system.

(2) Lecturers actively participate in research on topics related to learning management, whether they are university, regional or national-level topics, which will help expand lecturers' academic vision and further complete their professional knowledge system.

(3) Lecturers can use popular social media platforms such as Douyin, Bilibili, WeChat Video Accounts to follow influential social media accounts (KOLs) who are experts in their professional fields and develop their professional research potential by following up on information such as up-to-date academic perspectives and the latest research results that are updated and published regularly.

4.2 Encourage lecturers to continuously apply digital technology resources for learning.

(1) Executives develop a digital resource repository within the university, which can effectively encourage lecturers to continuously apply digital technology resources for learning.

(2) Executives set learning tasks by requiring lecturers to attend a specified number of online learning hours to promote their continuous learning, and develop effective stimulation mechanisms.

4.3 Encourage teachers to apply digital technology resources to analyze individual learning management approaches and support reflection and improvement of learning management.

(1) Executives develop smart classrooms that integrate intelligent recording systems, big data analysis technology, and various types of digital technology resources, by applying artificial

intelligence (AI) to support teachers to utilize smart classrooms to record learning management processes, analyze relevant data, directly understand learning management results, discover strengths and weaknesses, and adjust learning management strategies and classroom design appropriately.

(2) Executives develop a training framework closely linked to educational measurement theory, organize regular training activities on teachers' ability to create online questionnaires, so that teachers can use online questionnaires to comprehensively and deeply analyze individual learning management approaches, and provide reference information for improving learning management.

#### 5. Digital technology ability development guidelines and implementation methods.

5.1 Encourage teachers to understand the meaning of multimedia, Internet (INT), big data, virtual reality (VR), artificial intelligence (AI), and algorithms and solutions.

(1) Executives play an important role in promoting and developing digital skills of teaching personnel, which is carried out through systematic support mechanisms, including setting vision and policies, allocating necessary resources, and providing technical support. and evaluation of achievements.

(2) Executives support the application of innovative digital technology in learning management by organizing various learning promotion activities, such as inviting qualified persons as speakers, developing online platforms for knowledge exchange, organizing workshops, and training workshops.

(3) Encourage teachers to participate in various project competitions by supporting learning through competitions, promoting learning management through competitions, and promoting development through competitions to continuously increase teachers' knowledge and application of digital technology. After the competition is over, a process should be organized to summarize the results of the competition and publish the results so that more teachers can benefit.

(4) Executives promote teachers' self-learning through policy setting and creating incentive mechanisms to encourage teachers to regularly study and research information in the field of digital technology in order to understand the latest research results and technological advancements.

(5) Executives set incentive measures to encourage teachers to voluntarily form learning groups within the university and organize regular learning exchange activities.

(6) Executives emphasize the cultivation of teachers with outstanding potential and teachers with special abilities by using a pilot method from a group of talented personnel to develop the overall potential of all teachers.

5.2 Promote teachers to be proficient in using electronic boards, projectors, and other information technology devices in smart classrooms.

(1) Executives organize training on the use of specialized teaching equipment for teachers when they are first hired, by classifying training contents according to subject areas and complexity of the equipment, and establishing evaluation mechanisms and providing suggestions for development.

(2) Executives establish a special technical support team to provide continuous consultation and assistance, solve technical problems that teachers encounter in teaching, continuously develop the potential of using equipment, including maintenance and updating equipment to be up-to-date.

(3) Executives establish a teaching observation system to encourage teachers to develop their ability to integrate information technology equipment into teaching effectively, through demonstrations of teaching in their own classrooms and observation of teaching from other teachers.

(4) Executives encourage teachers to actively study and understand the use of equipment, through studying user manuals, researching and watching related online video media, and promoting cooperation and exchange of knowledge among teachers, through developing communication platforms and establishing reward mechanisms.

5.3 Promote teachers to choose digital equipment, software, and educational platforms that are appropriate for teaching.

(1) Executives organize training courses on the use of digital equipment, by conducting training classified by teachers' basic knowledge levels, combining lectures and practical exercises. To develop appropriate equipment selection skills.

(2) Administrators study the user experience of teachers and students, establish a trial mechanism and receive feedback to increase efficiency in equipment selection.

(3) Teachers create a learning community or online communication platform for exchanging knowledge and working together, with administrators providing structural support.

(4) Administrators organize off-campus study tour mechanisms for teachers to learn from leading organizations, understand the needs of the industrial sector and the trends in

technological development, to ensure that teaching resources are in line with the needs of the industrial sector.

(5) Utilize excellent curricula and disciplines to develop intensive professional foundation curricula, and apply appropriate digital learning management platforms to develop excellent curricula and disciplines.

6. Digital safety development guidelines and implementation methods.

6.1 Promote teachers' capacity to control legal access to the Internet.

(1) Administrators invite public security agencies to cooperate and organize regular lectures on topics related to legal access to the Internet to enhance teachers' cybersecurity legal awareness.

(2) Administrators develop a unified authentication system, requiring teachers to enter usernames and passwords to authenticate when accessing the university network, to ensure that only legitimate users can access network resources and enhance network security.

(3) Teachers enhance regulatory awareness and maintain a good level of network literacy at all times. Do not install VPN software, do not visit illegal websites, etc.

6.2 Encourage lecturers to maintain data security in their operations.

(1) Executives develop detailed data maintenance operation manuals and set related data maintenance operation requirements to supervise lecturers to maintain data security in their operations.

(2) Executives organize regular learning and training activities by inviting experts in the field of information technology to lecture in order to develop lecturers' potential in maintaining data security in their operations.

(3) Executives organize regular lectures on data security topics by making the lecture content more specific to guide lecturers to fully realize the importance of data in their operations and to reinforce the importance of maintaining data security in their operations.

(4) Lecturers should create good work habits, such as not storing work documents on public computers, regularly backing up important data, storing work data on personal storage devices, and encrypting important data, etc.

6.3 Encourage lecturers to instill data security awareness and behavior in students.

(1) The university assigns the mission of "ideological education in the curriculum" by specifying "data security awareness and behavior" as part of ideological education in the

curriculum. To encourage teachers to naturally and effectively convey information security awareness and behavior to students in daily teaching.

(2) Teachers should develop the habit of continuously learning information security knowledge, in order to accurately instill information security awareness and behavior in students.

### **Evaluation of the feasibility and utility of the guidelines and the handbook for development of 21st century digital skills for university teachers in Guangxi, China**

1. Five experts assessed the IOC of the guidelines and the handbook for development of 21st century digital skills for university teachers in Guangxi, China. The overall evaluation results were at a high level, with an IOC value of 0.8–1.00 for all items.

2. Thirty senior experts in the fields of big data and artificial intelligence (AI) assessed the feasibility and utility of the guidelines and the handbook for development of 21st century digital skills for university teachers in Guangxi, China. The overall evaluation results were at the highest level, both in terms of feasibility and utility. It indicating that the guidelines and the handbook was feasible and useful.

### **Discussions**

1. The analysis results of the current status of 21st century digital skills of university teachers in Guangxi, China. It shows that the digital skills of university teachers in Guangxi are at a high level overall, with the ranking of the following six main dimensions: (1) teaching ability, (2) learner ability, (3) innovative thinking and problem solving, (4) professional development ability, (5) digital technology ability (6) digital safety.

The results of the research show that, overall, university teachers in Guangxi have a high level of digital skills, which may be the result of a series of policies promulgated in recent years by the CPC Central Committee, the State Council, the Ministry of Education, and the Guangxi Provincial Government to support the development of teachers' digital skills, such as the "2035 Plan for the Development of Modern Education in China" (CPC Central Committee & the State Council, 2019), the "Digital Literacy of Teachers" (Ministry of Education, 2022), and the "Guangxi Education and Internet Action Plan (2018–2022)" (Department of Education, 2019), etc. These policies are important guarantees for the development of teachers' digital skills. In particular, the average teaching ability is high, which may be because teaching is the foundation of education, and teaching ability is the foundation of teachers.

The above research results are consistent with the research theory of Li (2025). In the information age, teachers' information literacy mainly refers to teachers' information-based teaching ability, which is the ability to integrate information technology with teachers' subject teaching knowledge and teaching activities.

2. The research results show that the guidelines for development of 21st century digital skills for university teachers in Guangxi, China mainly covers six core dimensions, namely: (1) teaching ability, (2) learner ability, (3) innovative thinking and problem-solving, (4) professional development ability, (5) digital technology ability (6) digital safety.

The above research results may be due to the need to improve the ability of university teachers and the digital transformation of education. In order to maintain competitiveness in the new era of education reform, university teachers in Guangxi must comprehensively improve their teaching ability to optimize classroom teaching effects, enhance learner ability to implement personalized guidance, cultivate innovative thinking to solve teaching practice problems, strengthen professional development ability to promote continuous growth, master digital technology ability to promote information-based teaching, and strengthen digital safety ability to ensure the stable operation of teaching activities.

The above research results are consistent with the theory of Lei and Zhao (2023). In the context of digital transformation of education, teachers should have four key abilities, namely digital teaching ability, digital evaluation ability, digital learning and training ability, and digital education ability.

3. The guidelines and the handbook for development of 21st century digital skills for university teachers in Guangxi, China have reached the highest level in terms of feasibility and utility.

The above research results may be due to the fact that the guidelines and the handbook have undergone rigorous expert review and evaluation procedures during the compilation process. These experts are senior experts in the field of big data and artificial intelligence in Guangxi, with profound theoretical knowledge and rich practical experience.

This is consistent with Li (2024) theory on strategies to improve the information technology literacy of university teachers. Based on the theory of “Information Technology Literacy Framework”, the researchers collected key data on university teachers' information technology applications through in-depth interviews and questionnaires and systematically analyzed the data to construct a path to improve the information technology literacy of university teachers. The

interviewed teachers all come from different disciplinary backgrounds and have been engaged in teaching and scientific research for a long time.

### **Knowledge from Research**

Researchers have comprehensively considered relevant concepts, theories, literature, and research, and formulated the “guidelines for development of 21st century digital skills for university teachers in Guangxi, China” to establish skill standards and related indicators for university teachers to enhance their digital skills. The research process included the analysis of survey data and interviews with teachers who won awards in the Guangxi Higher Education Information Competition and qualified experts according to the objectives. As a result, the components of 21st century digital skills for university teachers consist of 6 aspects, and for each aspect, specific development guidelines and related implementation methods are carefully formulated, providing specific and practical references for upgrading 21st century digital skills of university teachers in Guangxi.

### **Conclusion**

1. The current status of digital skills of college teachers in Guangxi in the 21st century is generally at a high level. Among them, the average level of teaching ability is the highest, followed by learning ability, and digital security is the lowest. Policy support provides a guarantee for the development of digital skills of college teachers in the 21st century. Teaching ability is the foundation of teachers, and the development of digital skills must ultimately serve the improvement of teaching quality.

2. The guidelines for development of 21st century digital skills for university teachers in Guangxi, China covers six core dimensions: teaching ability, learning ability, innovative thinking and problem-solving ability, professional development ability, digital technology ability, and digital security. These dimensions are based on the actual needs of teachers' digital transformation, and are both relatively independent and organically unified, and are jointly committed to improving the quality of higher education.

3. The guidelines and the handbook for development of 21st century digital skills for university teachers in Guangxi, China: the guidelines were rated at the highest level in terms of feasibility and utility. A strict expert review mechanism was established in the preparation of the guidelines and manuals, and after multiple rounds of argumentation, the professionalism and utility

of the content were ensured. It is recommended to promote the use of this guidelines and handbook in universities throughout Guangxi.

## Suggestions

### 1. Suggestions for implementation

In the digital age, the meaning of teaching ability has been expanded. Teachers need to be proficient in the application of information learning management tools, decision-making in data-based learning management, exploring innovative learning management methods, and integrating knowledge across disciplines. These digital skills have been integrated. Make teaching capabilities more diverse and comprehensive, and help teachers to transfer knowledge more effectively and creatively, in line with the needs of university education in the 21st century.

The research results found that the digital skills of teachers in the 21st century in universities in Guangxi cover 6 main dimensions: teaching ability, learner ability, innovative thinking and problem-solving, professional development ability, digital technology ability, and digital safety. These 6 main dimensions should be further developed through practical practice.

### 2. Suggestions for further research

In order to cope with the rapid development of artificial intelligence (AI), this research suggests studying the establishment of a dynamic adjustment mechanism, reducing the update cycle of the 21st century digital skills framework from one year to six months or three months, to ensure that the development of teachers' digital skills is in line with technological advances.

In the digital age, digital tools are diverse and powerful. However, these tools are only technological media that cannot judge their value and ethics by themselves. Therefore, the development of teachers' digital skills requires deep integration of technical capabilities with value creation.

Faced with the rapid development of digital transformation in the industrial field, the construction of digital capabilities of university teachers needs to be deeply integrated with the integration of industry and education, and research and construct a three-dimensional linkage mechanism of “industry demand–digital capabilities–education innovation”.

This study provides valuable insights for university teachers to enhance their 21st century digital skills. It not only meets the regional demands of Guangxi but also offers a replicable framework for the development of digital capabilities in higher education institutions across China.

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