



Requirements for information technology application competence for Vietnam agro-forestry students in the time of the 4th technology revolution

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Abstract

The professional work of today's agricultural and forestry engineers is changing dramatically under the impact of the 4th industrial revolution. In that context, the competence to apply information technology (IT) is one of the core and significant competencies. Therefore, in order for training products to meet the needs of society, one of the problems that training facility for agriculture and forestry industry need to solve is to clearly identify the basic requirements for agro-forestry graduates to meet the basic requirements of IT application competence. Based on theoretical and practical research on the IT application competence of each job position and the trend of employment change in the 4.0 period, the article presents the levels of IT application competence in the agro-forestry industry. On the basis of test results and opinions of experts and employers, the article has proposed the components and required levels of IT application competence for agro-forestry students. The research results, in addition to providing information on the current state of students' IT application competence, are also a good reference source for agro-forestry training institutions to set learning outcomes, develop training programs, and innovate new training methods to promptly provide high-quality human resources for the agro-forestry industry in the context of the 4th industrial revolution.

Keywords: Agro-forestry students, Agro-forestry students, Employment area, Employment trend, Job position, Levels of IT application competence.

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Contribution of this paper to the literature

The study has determined the level of students' IT application competence that consistent with the current popular employment trends of agricultural and forestry students. This is an important basis for devising specific measures to improve students' capacity and level of IT application competence for real-life careers.

1. Introduction

These days, agriculture is one of the priority areas for digital transformation, which has helped the application of digital technology in production, processing, and agribusiness make strong progress. The change in technology has led to changes in the professional work and diversity of workers. Today's agro-forestry engineers can work in state agencies; businesses, companies, and farms; consult for international organizations; teach and research at universities, colleges, and research institutes or start their own businesses. In addition, a part of them becomes a global human resource (Fizer, 2013; Ogunsina & Taiwo, 2018; TUAF, 2023a).

Each of the above job positions will have different requirements for IT qualifications for employees. In the study of Perdigones, Valera, Moreda, and García (2014), employers in private companies require employees to be proficient in spreadsheets, Autocard, and commercial software. At research facilities, it is required to perform well on office software, SPSS, ArcGIS, and ArcView. In the field of agribusiness, Erickson, Fausti, Clay, and Clay (2018) made the requirements of employers for the position of equipment operator and technical support, including being proficient in installations, operations, calibrations, precisely troubleshooting, and repairing agricultural equipment, and being good at using software to control these devices. In Vietnam, the requirements for IT qualifications are clearly stated in the recruitment notices of each job area. For government agencies, the requirements for skills in using the Internet and office and specialized software are mandatory (Ministry of Agriculture and Rural Development, 2020), while private enterprises and companies focus on skills in using smart agricultural equipment, specialized software, analyzing data, and promoting and introducing products (TUAF, 2021).

According to statistics from recent studies, students' IT application competence has not yet met the requirements of actual work. In a survey by Perdigones et al. (2014) on students' ability to use computers in Spain, with a scale from 1 to 5, while the score required by employers is 4.12, students majoring in agricultural techniques only achieved 2.6. According to research by Ndem, Ogba, and Egbe (2015) students only have theoretical knowledge about some machinery and equipment used in agriculture but have not yet used them. In some European countries, there are not yet skilled workers in the agricultural sector to exploit the potentials of data processing and analysis, communication through digital technology, use of field operations management and farm management information systems, e-commerce and e-marketing (Ramalho Ribeiro et al., 2023). In Vietnam, we conducted a survey for students at The University of Agriculture and Forestry – Thai Nguyen University (TUAF). The results show that the average IT application competence of students is 3.63 compared to the employer's requirement of 3.78, in which the difference is quite high in the criteria of searching and exploiting information on the Internet, using computers and smart agricultural devices, communicating and collaborating using technology in the media (Toan, 2022). From the above studies, it can be seen that the IT application competence of students has not yet met the needs of employers, especially those related to new technological trends in agriculture today.

The different requirements in each job position and the constant changes under the influence of digital technology have created urgent problems for university education in general and training in the agricultural sector, in particular, to figure out how to make students' IT competence after graduation meet the requirements of employers and the needs of society. The proposal of measures to improve the students' IT application competence has been carried out in many studies. According to Champa and Priyantha (2015) it is necessary to invest in IT infrastructure, improve the quality of Internet connection, integrate IT tools in the teaching and learning process, establish help centers and fix computer problems, and create a virtual learning environment to teach IT topics. According to Vázquez-Cano, León Urrutia, Parra-González, and López Meneses (2020) it is necessary to redesign the training matrix in the direction of promoting socially-digital meaningful learning and design the learning environment in an effective, interactive, flexible, and reflective way. Bournaris et al. (2022) claim that it is necessary to revise the training program, which integrates improvements in technology and communication, and add precise courses on agriculture for students in all grades. In recent research, it is suggested by Ramalho Ribeiro et al. (2023) that a tailored interdisciplinary approach, in collaboration with stakeholders, is needed to create a skill set that includes technical skills, digital skills, soft skills, business skills, and market making. As can be seen, all mentioned measures are aimed at updating the curriculum, and training forms, creating a flexible, meaningful teaching and learning environment, with a connection to the actual profession. In the above measures, updating the training program plays an extremely important role to ensure that students are equipped with suitable skills to meet the requirements of the industry.

Updating the training program includes the adjustment of subjects, content, materials, and teaching methods with close relation to the output standards in the field that the training program aims to. Output standards refer to the required level of competencies after completing the training program. In previous studies, we have built an IT output standard for students through a framework of IT application competence specifically for students in the agricultural field (Toan, Hai, & Kien, 2023). To determine the required level of each component competence in the competency framework, this study analyzes the current employment trends of students and the requirements for IT application competence in each of those trends. This identification will create a basis for orientation for the design and development of training programs and provide specific solutions to improve the quality of training in Informatics in current agro-forestry institutions.

2. Research Methodology

In this article, we use theoretical and practical research methods to systematize and analyze documents related to job trends and requirements for IT application competence in the work of agro-forestry engineers. The expert method is used to test the predicted competence level. Finally, the data processing method is used to summarize the collected data. The steps to conduct the research are done as follows:

Step 1: Analyze employment trends of agro-forestry engineers in recent years.

Step 2: Analyze the requirements of IT application competence in specific jobs and predict the level of competence to be achieved.

- Step 3: Get experts' opinions on the predicted competence level.
- Step 4: Test on a limited number of samples to check students' achievement.
- Step 5: Give the required level of each component competence.

The publication of the student's employment situation is a mandatory requirement for educational institutions in recent years and is published on the websites of the institutions. Therefore, in step 1, we analyzed the data in survey reports on the employment situation of students after graduating from 2018 to 2022 on the website of [TUAF \(2023b\)](#); [BAFU \(2023\)](#); [VNUF \(2023\)](#); [TTU \(2023\)](#); [HVVU \(2023\)](#) and [TNU \(2023\)](#).

For the predicted competence level to match the requirements of the actual job, we collected experts' opinions in Step 3. The experts consulted are employers in each specific field, in which the percentage of experts surveyed in each employment sector will be based on popular employment trends (about 50% of employers are in the private sector, 40% of employers are in the sector of joint ventures with foreign countries, 10% of employers are in the public sector). The collection of experts' opinions was done through interviews and the distribution of questionnaires using the 5-Point Likert Scale. The results are evaluated according to the interval scale in [Table 1](#) as follows:

Table 1. Interval scale and description by mean value.

Value	Competence level	Descriptions
1 - 1.80	Poor	Have no or very little understanding of IT applications, cannot use IT applications.
1.81 - 2.60	Basic	List the role of IT applications and perform simple tasks but have limited skills in implementing IT applications.
2.61 - 3.40	Average	Describe the function of IT applications and implement IT applications at work.
3.41 - 4.20	High	Present how to apply IT applications and competently perform operations that bring efficiency to work.
4.21 - 5.00	Very high	Analyze IT applications, proactively propose solutions, guide other students to effectively implement of IT applications at work.

Step 4 measured the student's competence on a limited number of samples to test the reasonableness of the proposed levels, thereby giving a table of levels to be achieved for each component competency in the IT application competency framework in Step 5.

3. Research Findings

3.1. IT Application Competence in Agriculture and Forestry

Inheriting the studies on the concept of career, competence, and IT, this research uses the concept of IT application competence, which is the integration of individual components of knowledge, skills, and attitudes to ensure the effective completion of specific tasks. Thus, the IT application competence in agriculture and forestry is the integration of knowledge, skills, and attitudes of individuals to ensure the effective completion of specific tasks related to creating, processing, transmitting information, storing, and exploiting information on agriculture and forestry.

IT application competence is a component skill in the professional competence of engineers in the agro-forestry industry. Depending on the level of IT application in each major, there are differences in the IT-related output standards in each of those majors. However, all institutions have common requirements for basic IT skills to meet the general requirements of society for workers (03/2014/Ministry of Information and Communications (2014)). According to this requirement, in order to achieve IT output standards, students need to have a basic IT understanding and basic abilities in computer, Internet, and office applications use. In addition, there are additional requirements depending on specific specialties. The [Table 2](#) shows the output standards related to the application of IT in Agriculture and Forestry majors on the website of universities: TUAF, Vietnam National University of Forestry (VNUF), Vietnam National University of Agriculture (VNUA), Hue University of Agriculture and Forestry (HUAF).

Table 2. Output standards for IT application in agriculture and forestry.

Institutions	Output standards of the forestry industry	Output standards for the agriculture industry
TUAF	Apply advanced technologies in tracking and monitoring changes in forest resources. Use IT, and multimedia communication tools and apply soft skills in professional activities. Proficiently use maps and a number of tools (Global positioning system (GPS), Geographic information system (GIS)) for professional work.	Apply IT and automation techniques to control the growth and development of plants; diagnose, treat, and control animal diseases; and ensure food hygiene and safety. Use multimedia communication methods.
VNUF, VNUA	Proficiently use specialized computer software. Implement communication on the media and advertise on the internet. Master new and advanced science, technology, and labor tools.	Complete the technical process of high-tech crop production in accordance with practical conditions. Have multi-media communication skills.
HUAF	Proficiently use community outreach methods, especially GIS, remote sensing, supporting tools, and some specialized software in tracking and monitoring forest resource developments. Proficiently use professional toolkits in analyzing and evaluating results in scientific experiments and specialized investigations.	Apply technological advances in agricultural production. Implement technological processes in production and animal husbandry.

According to the table, the IT requirements in agro-forestry majors are related to skills in using IT and modern equipment of the profession; communication skills using multimedia tools; Blockchain application, and forms of e-commerce in agricultural production and business. Some institutions have mentioned the use of digital technology, automation equipment, and software in some subjects of their training programs. However, these subjects are mostly optional and have not been specified through the output standards of the training industry. Therefore, it is necessary to have separate IT output standards for each industry that are updated regularly under the influence of digital technology. We have built a framework for IT application competence specifically for students in agriculture and forestry. The

Competency Framework has detailed information about IT competence that students of agriculture and forestry need to have to meet the requirements of employers. The specific determination of the required level of each competency will be the basis for putting the competencies framework into practice.

3.2. Employment Trends of Agro-Forestry Engineers in Recent Years

According to the statistical results at the universities offering training in agriculture and forestry, including TUAF, Bacgiang Agriculture and Forestry University, Vietnam National University of Forestry, Tantrao University, Hungvuong University, and Taynguyen University, the average percentages in employment sectors for the period 2018-2022 are as follows:

Table 3. Statistical table of the participation in employment sectors of graduates from 2018 to 2022.

Year	Public sector	Private sector	Self-employment	Joint ventures with foreign countries
2018	19.66	55.12	10.92	12.48
2019	15.13	44.04	20.45	7.05
2020	8.68	67.55	11.76	12.66
2021	5.56	72.3	9.66	7.49
2022	7.16	42.95	26.79	23.07

The data in Table 3 are illustrated more clearly through the chart in Figure 1. This figure shows that, the employment trend of students in the past 5 years has changed dramatically. Employment in the public sector decreased sharply as students mainly worked in the private sector. This is also consistent with the general situation of our country today: State agencies limit recruitment and increase downsizing; young people tend to gradually move to work in private enterprises, where there is a challenging working environment but the salary is in accordance with their dynamism, qualifications, and working skills. However, in some professions, such as agricultural extension, rural development, or forest resource management, the public sector is still the main employment area.

A prominent trend in recent years is that many graduates have started their own businesses through many forms, such as self-employment, creating career-building groups, joining traditional occupations, or working in family businesses. This considerable increase demonstrates the dynamism and confidence of students in their professional expertise.

The trend of employment in joint ventures with foreign countries has also increased significantly, in which most of the students who have participated in cooperation programs of universities with foreign partners work in this sector. The trend of participating in professional internship programs abroad with salary is increasingly popular. Most agro-forestry training institutions have cooperation programs with foreign partners so that students can have professional internships and graduate internships in countries with developed agriculture in order to improve their professional capacity and have access to a modern and professional environment. Every year, there are thousands of students majoring in agriculture and forestry institutions participate, and 6-8% of them have stayed to work long-term in those countries.

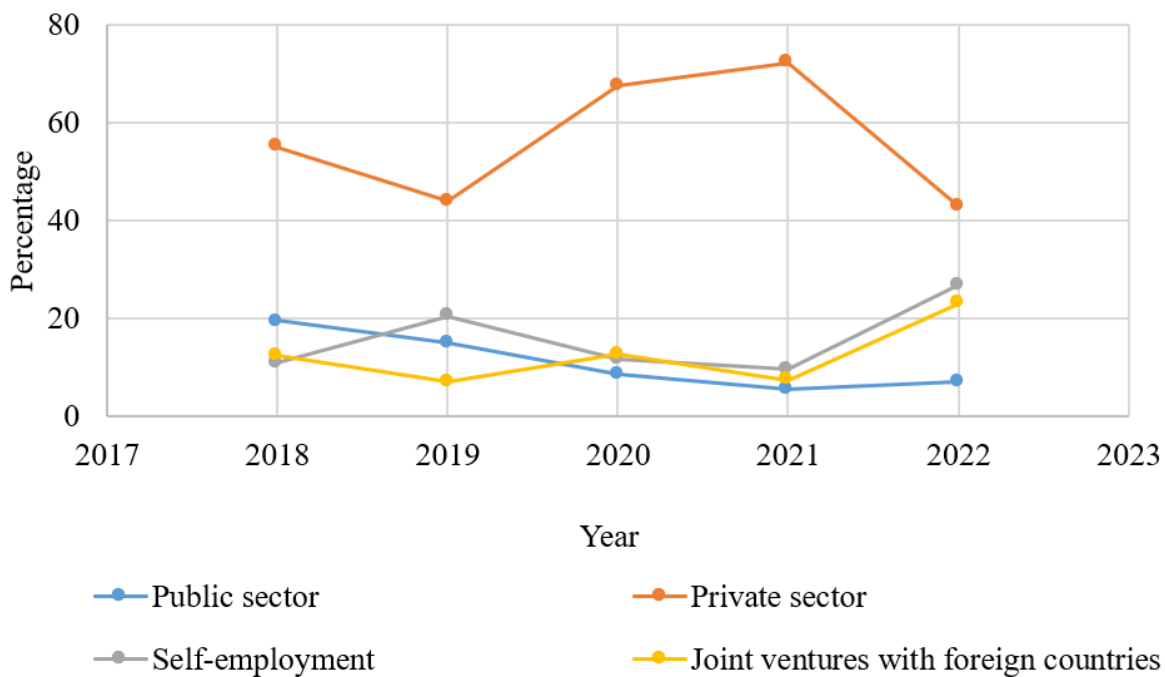


Figure 1. Participation rate in employment sectors of graduates from 2018 to 2022.

3.3. Determining the Level of IT Application Competence to Be Achieved

Firstly, the predicted level of IT application competence to be achieved for each specific industry is given. To get these degrees, we analyzed and synthesized the requirements for IT application in each job position of agricultural and forestry engineers in companies, enterprises, and state agencies and requirements in the recruitment notices.

Next, to test the above prediction results, the collection of expert opinions through interviews and direct distribution of questionnaires was carried out. The experts consulted are employers in each employment sector. The number of experts was based on the percentage of students working in that area. The survey results are averaged for each component competence. From the obtained results, we make some conclusions as follows:

There is a difference between the job requirements in the same industry. Specifically, the private sector and joint ventures with foreign countries have higher requirements on the competence of using specialized software than the public sector. Competence related to the promotion and introduction of products by digital technologies is of great interest to many employers in the private sector. The area of joint ventures with foreign countries focuses more on the competence to exploit and use information and the capacity to use automatic control equipment and software. Employers in the public

sector are more interested in the competence to use office equipment and software, the competence of understanding IT, the competence to exploit and use information, and social competence.

The competence to detect opportunities for IT application and the competence to develop professional skills are highly appreciated by employers. According to some employers, employees must achieve a high level of other competence to propose opportunities to apply IT and solutions to improve work quality and efficiency through the proper use of IT applications.

Previously, we conducted a study to evaluate the IT application competence of students at TUAF (Toan, 2022). In the collected data, we use survey information on forestry students. The results of students' self-assessment compared to the proposed competency level are shown in the Figure 2:

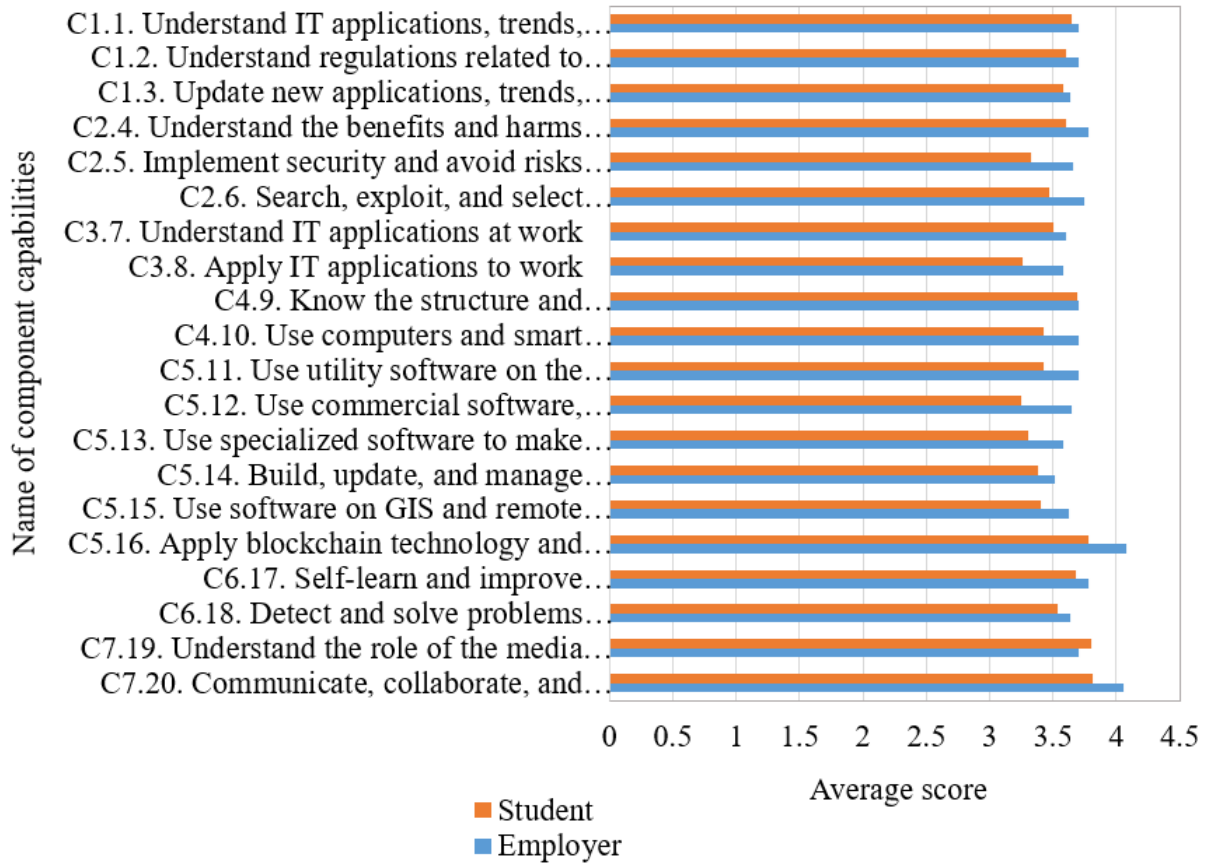


Figure 2. Comparison of the self-assessment level of students and the requirements of employers.

According to the results obtained from the figure above, most of the competence criteria that students accumulate are lower than the required level. The low difference belongs to the criteria related to the competence to understand IT, to use technical means, and to use some software. These are all mandatory requirements in the training program for forestry students. The high difference belongs to the criteria related to the use of technologies, smart devices, and new forms of security and communication in forestry production and business. These are new problems in agriculture today, which can be reflected in the training program, but students have little or no actual training. This result shows that the determined competence levels are consistent with current training and occupation practice.

From the above prediction and testing process, we give the final results on the level of competence that students of each major in the field of agriculture need to achieve after the training process as follows:

Based on the levels of competence in Table 1 and the level that students need to achieve in Table 4, it can be seen that the level of competence that employers require the most belongs to the competence to self-study and improve the IT application competence in the profession, the competence of communication, cooperation, and promotion through technology in the media. This is consistent with the development of today's society. In order to keep up with the constant changes in technology, employees need to constantly self-study and participate in courses and training to improve their professional qualifications. Along with that, forms of working, cooperation, and agribusiness are also diverse with the use of media instead of direct, face-to-face forms. To support this process, applications of Blockchain and other forms of e-commerce are widely and effectively used. These are the competencies that employers are very interested in. Next are skills related to understanding IT applications in general work, using specialized software, equipment in smart agriculture, and forms of security when using the Internet. For these competencies, the differences depend on the characteristics of each industry, but most of them have high requirements. The remaining competence requires an average level or higher.

Thus, it can be affirmed that IT is an indispensable competence for engineers in agriculture today. This is also a significant issue for employers. This poses an urgent requirement for educational institutions, which need to come up with appropriate and timely measures so that the quality of training can meet the needs of the digitalization process of Vietnam's agriculture today.

Table 4. IT application competence level to be achieved by students in agriculture and forestry.

List of competence	Capacity level			
	Forestry	Agriculture	RE	Food technology
(1). IT literacy competence C1.1. Understand IT applications, trends, and policies in the professional field.	4.1	4.1	3.4	3.4
C1.2. Understand regulations related to IT law in behaviors and professional work.	4.2	4.2	4.1	4.1
C1.3. Update new applications, trends, and policies on IT applications in the professional field.	4.1	4.2	4.1	4.1
(2). Competence to exploit, use information, and avoid risks on the internet C2.4. Understand the benefits and harms of the internet.	4.2	4.2	4.2	4.2
C2.5. Implement security and avoid risks when working on the internet.	4.1	3.4	4.1	3.4
C2.6. Search, exploit, and select information on the internet for professional activities.	4.2	4.2	4.2	4.2
(3). Competence to detect IT application opportunities C3.7. Understand IT applications at work.	3.4	4.1	4.1	3.4
C3.8. Apply IT applications to work.	4.1	4.1	4.1	3.4
(4). Competence to use technical devices C4.9. Know the structure and maintenance of equipment such as computers, automation control systems, measuring equipment, and remote monitoring.	4.1	4.2	4.1	3.4
C4.10. Use computers and smart agricultural equipment.	4.1	4.1	3.4	3.4
(5). Competence to apply software C5.11. Use utility software on the operating system and basic office software.	4.2	4.2	4.2	4.2
C5.12. Use commercial software, automatic control software, and remote monitoring.	4.2	4.2	3.4	4.1
C5.13. Use specialized software to make statistics, process data, analyze the market, and calculate indexes.	4.1	4.2	3.4	4.2
C5.14. Build, update, and manage specialized databases.	4.1	3.4	4.1	3.1
C5.15. Use software on GIS and remote sensing to solve problems in the field of agriculture.	4.1	4.1	4.2	3.1
C5.16. Apply blockchain technology and forms of e-commerce in agricultural production and business.	4.1	4.1	3.4	4.1
(6). Professional development competence C6.17. Self-learn and improve knowledge of IT applications in the profession.	4.2	4.2	4.2	4.2
C6.18. Detect and solve problems related to IT applications in the professional field.	4.1	3.4	4.1	3.4
(7). Social competence C7.19. Understand the role of the media in the professional field.	4.2	4.2	4.1	4.2
C7.20. Communicate, collaborate, and promote the use of technology in the media in the professional field.	4.2	4.2	4.1	4.2

4. Conclusion

Through the process of analyzing documents and practical testing, the article has identified a table of levels to be achieved in terms of students' application competence in each specific industry. The results of the article play an important role in the development of training programs, serving as the basis for adjusting the number of subjects, preparing the conditions of facilities, and renovating the contents, teaching methods, and forms of examination and assessment accordingly. With the current strong development of digital technology, educational institutions in the field of agriculture need to update new requirements on IT application competence regularly and continuously; thereby making timely adjustments so that training is associated with social needs.

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