

Competence framework of information technology for students of Thai Nguyen University of Agriculture and Forestry

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ABSTRACT

Currently, with the positive impact of information technology (IT), the world's agriculture is gradually shifting from the traditional agricultural model to the digital agricultural model, creating high productivity, increasing the product value and labor productivity. However, the agriculture with applied digital also requires laborers to be capable of applying IT in the agricultural sector. On the basis of theoretical research, output standards from bachelor training programs in the field of agriculture in the world and Vietnam, along with practical investigation results, the article focuses on two main contents: clarify the content of IT application capacity of a student in the field of agriculture and forestry; building a competence framework and assessment criteria for IT application competence for students in the field of agriculture and forestry. The results of the article are documents for Thai Nguyen University of Agriculture and Forestry as well as training institutions for bachelors and engineers in agriculture and forestry to refer to in the process of developing training programs, assessing outcomes for students, as well as innovating training methods towards developing learners' capacity.

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1. INTRODUCTION

The popular trend of information technology application in industries has led to changes in all aspects of technical processes, production methods as well as business methods [1]. In order to operate and meet the demands of actual work, the requirement of information technology (IT) capacity is mandatory for all employees in society. Currently, many countries around the world have built their own IT competence frameworks [2]. The frameworks are geared towards general IT knowledge and skills. For each specific field, besides general competencies, there are also specific competencies related to the characteristics and level of IT application of work in that field. There have been a number of studies conducted in a number of areas, such as: education [3], [4], accounting [5], general workers in developing countries [6], librarians [7], and students [8], [9]. Building a competence framework of IT application is necessary. It serves as a basis to help agencies and enterprises in the process of recruiting, evaluating staff, developing training and retraining plans for the unit, and improving the quality of training in educational institutions.

In Vietnam, besides the competence framework of IT for workers in general [10], most of the studies that have been done focus only on building the framework for teachers [11], students in the fields of

IT [12], [13], and education [14], [15]. No research has been done on the agro-forestry sector. In addition, the results of IT training for students in this field in many educational institutions have not yet met the requirements of employers [16], [17]. In such a situation, we conduct research to clarify the characteristics of the competence of applying IT for students in agriculture and forestry, building a competence framework and criteria for assessing students' IT applying competence. The results obtained from the research are important documents for the training institutions of agricultural human resources in the process of developing training programs and innovating training methods to create training products that meet the needs of today's ever-changing society. Agencies and enterprises in the field of agriculture can also refer to the framework in the recruitment and training of their staff.

2. RESEARCH METHOD

To conduct this study, firstly we used group of theoretical research methods: Analysis, synthesis, systematization of documents on the information technology competence framework, specific applications of IT in agricultural work in order to have a full and profound awareness of research issues, developing a basis for conducting further studies. Then we use group of practical research methods. Using the mixed method [18], [19] by a combination of methods as: investigation, observation, interview, professional solution, research, and experiment to serve as a basis for confirmation, processing results and completing the framework as well as appropriate evaluation criteria. To conduct the survey, we built in-depth interview questions and questionnaires for lecturers, researchers, and employers. Our implementation steps are concretized through the diagram in Figure 1.

In the first stage, the qualitative method is applied on a small sample with the aim of identifying problems related to the IT application competence of students in agriculture and forestry. The data in this stage was collected by in-depth interview method with a sample of 5 lecturers teaching General Informatics, Applied Informatics, and 3 recruiters from manufacturing and business companies in the agriculture sector. In the next stage, the survey method by questionnaire combined with case study is used on a large sample to provide a competence framework and criteria for assessing students' IT application competence. The survey sample includes lecturers, researchers who are knowledgeable about IT applications and employers in specific areas of expertise such as: Cultivation, animal husbandry, processing and agribusiness. After receiving feedback from experts, the framework was revised and sent to them again for further comments. This process is repeated until there is a high consensus from the experts. In this step, we went through three rounds with comments from 16 lecturers (teaching General Informatics, Applied Informatics at University of Agriculture and Forestry and University of Information and Communication Technology), 12 experts (7 directors of agricultural and forestry research centers, 5 researchers in IT education), 08 employers (as Directors, heads, deputy heads of departments working at state management agencies and production companies related to agricultural production and business). In the final stage, we test and evaluate students' IT application capacity according to the set of criteria that have been built to analyze and adjust accordingly.

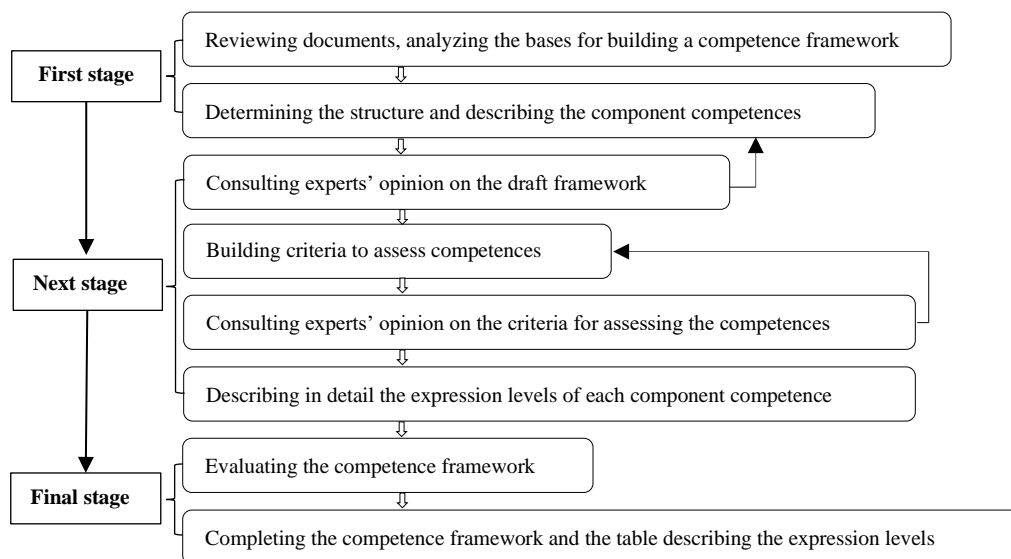


Figure 1. Stages and steps of building the framework

The study was carried out by us from January 2020 to July 2022 in Thai Nguyen province. This is where many universities are located, including Thai Nguyen University of Agriculture and Forestry, which trains high-quality human resources in the fields of agriculture and forestry, rural development, natural resources, environment and valuable scientific and technological products [20]. In addition, this is also home to many research centers and production and business enterprises in the field of agriculture.

3. RESULTS AND DISCUSSION

3.1. Competence in applying information technology of students of agriculture and forestry

3.1.1. Concepts

Information technology was introduced after the second scientific and technical revolution (1871-1914) with the aim of replacing part of brain labor, helping with the control part with human intelligence [21]. There are many definitions of IT that have been given. According to Burgelman [22], information technology refers largely to the resources applied by a firm in the processing and management of its data. These resources include hardware, software, communications (voice, data, and video) and associated personnel. The Information Technology Association of America (ITAA) [23] definition: "IT study, design, development, application, implementation, support, or management of computer-based information systems." In Vietnam, IT is understood as a collection of scientific methods, technologies and modern technical tools for the production, transmission, collection, processing, storage and exchange of digital information [24]. Besides, the concepts of IT and ICT are used uniformly because the concept of IT contains elements related to the transmission, distribution and exchange of information. As can be seen, the term IT refers to software, internet networks, computer systems used for the production, distribution and processing of data, exchange, storage and use of information in the form of different consciousness. In other words, IT is the use of modern technology to create, process, transmit, store and exploit information. IT application is the use of IT for specific activities or purposes.

Similar to the concept of IT, there are many concepts of competence that are given according to different fields. In this article, we use the concept of competence in the direction of performance: "Competence is the mobilization and synthesis of knowledge, skills and other personal attributes such as interest, belief, will, in the successful implementation of activities, effectively solving tasks in a certain context" [25]. This concept emphasizes the ability to work effectively and be successful in a specific job.

From the previous interpretation of the concept of capacity and IT, we define: IT application competence is the ability to flexibly apply knowledge, skills and attitudes to use IT in exploiting, processing and sharing information in order to achieve effective results in specific situations. The IT application is the use of IT resources/tools for a given task. Thus, the ability to apply IT of students in the agriculture and forestry sector is the level achieved in terms of knowledge, skills and attitudes to use IT in order to effectively perform tasks related to learning and expertise of the trained profession.

3.1.2. Component competences

Employees in all professions in Vietnam today must meet the general requirements for informatics qualifications specified in Circular 03/2014 of the Ministry of Information and Communications. At the basic level, workers need to achieve: basic IT understanding, basic computer use, basic word processing, basic spreadsheet processing, basic presentation usage, and basic internet usage [10]. Depending on the characteristics of a profession and the level of IT application in that profession, there are other requirements. Based on the analysis of the requirements in the job positions of agricultural and forestry engineers in the recruitment notices in the documents [26], [27], we offer IT applications in the professional work of agro-forestry engineers, including: Instructing, managing, monitoring, handling and troubleshooting on technical processes in the processes of growing, raising, producing and preserving products; Using specialized machinery and equipment such as: All kinds of machinery and equipment to support agricultural production, equipment for analyzing nutrition, feed ingredients; forest fire prevention and fighting equipment, high-tech equipment, GPS machine; Research the dosage of fertilizers, feed and drugs for plants and animals. Applying advanced technology and advances in science and technology to research, test and create new varieties with higher yield and quality; Implement the steps of planning, organizing production and business, developing products according to the value chain, developing the market for agro-forestry; Surveying, investigating, planning the use and management of land and forests; Advise and organize the implementation of legal policies on agriculture, forestry, natural resources and environment; Develop documents and implementation plans for programs related to agriculture and forestry; Training, fostering, consulting and propagating on skills, production organization methods, production processes and scientific and technical advances in agriculture and forestry; Building and updating industry databases; Apply GIS and remote sensing technologies to solve problems in agriculture, forestry, land management, natural resources and environment.

Output standards for professions in the agro-forestry bachelor's and engineering programs of Thai Nguyen University of Agriculture and Forestry [28], Vietnam Academy of Agriculture [29] and Hue University of Agriculture and Forestry [30] as well set out the requirements to be achieved by students after graduation as: Satisfy the requirements for basic IT skills; Proficient in IT application skills in: Real estate management and business; tour guide, event organization, reception, services in the field of hotel and restaurant; bio-safe breeding, ensuring food hygiene and safety; diagnose, treat and control animal diseases, ensure food hygiene and safety; agricultural product quality management and traceability; Proficient in the use of specialized equipment and software systems in assessing and building a land management database. Making annual land use planning and plans; Using specialized software for bioinformatics in laboratories and factories in the field of biotechnology; Proficiently use data processing software, informatics software in production, cultivation, animal husbandry, resource management and environment; Applying advanced technologies in: Agro-forestry production, controlling and monitoring changes in forest resources, forecasting pests and diseases and forest fires; Using the media in the management, production and trading of agricultural products; Proficiently use automation equipment and techniques in controlling the growth and development of crops to improve productivity and product quality. Stemming from the requirements of jobs in the agricultural field and the current practice of training agro-forestry engineers, we determine that the IT application competence of students in this profession includes two main groups of competences with different specific skills are described in Table 1.

Table 1. The general competence framework

Competence	Description
General competence	
1. Competence of knowledge about IT	Understanding IT applications, trends, policies and regulations in the area of expertise.
2. Competence of using basic software	Using utilities and office software in professional activities.
3. Competence exploiting and using information	Exploiting and selecting services for professional activities. Avoiding risks when using the internet.
4. Competence of communicating	Communicating and cooperating through media and behaving in the digital environment.
Competence of profession	
5. Competence of using machines and technical means	Understanding the structure, how to maintain and use computers and devices in smart agriculture.
6. Competence of using specialized applications	Using specialized software, commercial software, control software, automatic monitoring, blockchain technology and forms of e-commerce.
7. Competence of professional development	Positive attitude, proactive in researching new trends. Applying IT on a regular basis in professional activities.

3.2. The competence framework of information technology application and specific expressions

After several steps as described in Table 1, the researchers have provided the competence framework and detailed description of the expression levels of each competence. For ease of use, the competency framework primarily describes knowledge and skills, and attitudes will be described where applicable. Table 2 shows the content of the competencies and 21 criteria in the competency framework.

Competencies C1.1, C2.5, C5.11, C7.20, and C7.21 included in the competency framework ensure the requirements specified in the general national competency framework [10]; some competencies are consistent with the studies conducted on the general requirements for Vietnamese students [11]. Competencies such as C4, C5, and C6 represent specific characteristics of jobs in the agricultural sector. In addition, we propose to add C3 capacity, which is not mentioned in previous studies. In the opinion of many employers, this is a necessary capacity for employees to improve working efficiency in the face of the diverse requirements of today's jobs.

To evaluate the criteria, we use four levels of achievement of competence. Level 1 (None): Not understanding existing IT applications, being unable to use IT applications. Level 2 (Low): Understanding the limitations and using IT applications, still being confused when applying. Level 3 (Medium): Applying IT applications at work. Level 4 (High): Actively applying IT applications at work effectively, guiding others to implement those applications. With the competence framework and the criteria, the expression levels of each component competence are described in detail in Table 3 to Table 9, respectively.

Table 3 shows the expressions used to evaluate the three criteria in competence of knowledge about IT (C1), while Table 4 evaluates the three criteria in the competence exploiting and using information (C2). Table 5 evaluates the two criteria in competence of discovering opportunities of IT application (C3). Table 6 judges the two criteria in the competence of using machines and technical means (C4), while Table 7 judges the six criteria in the competence of applying software (C5). Lastly, Table 8 assess the three criteria in the Competence of professional development (C6) and Table 9 assess the two criteria in the competence of

socializing (C7). This is the basis for teachers, students and employers to accurately assess the level of accumulation attained as well as the actual work requirements for each capability.

Table 2. The competence framework and specific criteria

Competence	Criteria
C1: Competence of knowledge about IT	C1.1. Understanding IT applications, trends, policies and regulations in the area of expertise C1.2. Having skills to update IT applications, trends, policies and regulations in the area of expertise C1.3. Understanding regulations of using and developing IT in the area of expertise
C2: Competence exploiting and using information	C2.4. Having the skills of information security and prevention of risks when working on the internet C2.5. Having the skills of searching, exploiting and selecting useful information on the internet for professional activities
C3: Competence of discovering opportunities of IT application	C3.6. Identifying activities that can be performed using IT applications C3.7. Selecting the appropriate IT applications to perform each specific activity C3.8. Offering opportunities to apply IT to perform specific activities
C4: Competence of using machines and technical means	C4.9. Understanding of the structure and maintenance of equipment such as computers, automatic control systems, measuring devices, remote monitoring devices C4.10. Having the skills of using computers and smart agricultural equipment
C5: Competence of applying software	C5.11. Having the skills of using utility software on operating systems, basic office software C5.12. Having the skills of using commercial software, automatic control software, remote monitoring C5.13. Having the skills of using specialized software for statistics, data processing, market analysis, index calculation C5.14. Having the skills of building, updating and managing specialized databases C5.15. Having the skills of using GIS and remote sensing software to solve problems in the field of agriculture and forestry C5.16. Having the skills of applying blockchain technology and forms of e-commerce in production and business
C6: Competence of professional development	C6.17. Having a sense of self-study, innovation, creativity and professional capacity building C6.18. Actively, proactively researching and updating new trends in the professional field C6.19. Proactively proposing solutions to improve work quality and efficiency through appropriate IT applications
C7: Competence of socializing	C7.20. Having communication and cooperation skills using technology in the media C7.21. Applying the rules of conduct in the digital environment to have appropriate awareness and employment

Table 3. Expression levels of competence of knowledge about IT

Criteria	Level of expression			
	4	3	2	1
1	Having a complete and accurate understanding of IT applications, regularly updating IT trends, policies and regulations in the area of expertise. Having an in-depth assessment of those trends and policies.	Having a relatively complete and accurate understanding of IT applications, regularly updating IT trends, policies and regulations in the area of expertise. Making some assessments about those trends and policies.	Having an incomplete and inaccurate understanding about IT applications, occasionally updating IT trends, policies and regulations in the area of expertise. Rarely making assessments about those trends and policies.	Having no understanding of IT applications, never updating IT trends, policies and regulations the area of expertise.
2	Having proficient skills in updating new applications, trends, and policies on IT applications in the area of expertise.	Having relatively proficient skills in updating new applications, trends, and policies on IT applications in the area of expertise.	Having inefficient skills in updating new applications, trends, and policies on IT applications in the area of expertise.	Having no skills in updating new applications, trends, and policies on IT applications in the area of expertise.
3	Have a complete and accurate understanding of the regulations on the use and development of IT in the area of expertise.	Have a relatively complete and accurate understanding of the regulations on the use and development of IT in the area of expertise.	Have an understanding, though incomplete and inaccurate, of the regulations on the use and development of IT in the area of expertise.	Have no understanding of the regulations on the use and development of IT in the area of expertise.

Table 4. Expression levels of competence exploiting and using information

Criteria	Level of expression			
	4	3	2	1
4	Having proficient skills in avoiding risks when working on the internet.	Having relatively proficient skills in avoiding risks when working on the internet.	Being confused when implementing skills of avoiding risks when working on the internet.	Being unable to implement skills of avoiding risks when working on the internet.
5	Having proficient skills in searching, exploiting and selecting useful information on the internet for professional activities.	Having relatively proficient skills in searching, exploiting and selecting useful information on the internet for professional activities.	Having inefficient skills in searching, exploiting and selecting useful information on the internet for professional activities.	Having no skills in searching, exploiting and selecting useful information on the internet for professional activities.

Table 5. Expression levels of competence of discovering opportunities of IT application

Criteria	Level of expression			
	4	3	2	1
6	Completely and accurately identifying what jobs can be solved using IT applications.	Nearly completely and accurately identifying what jobs can be solved using IT applications.	Incompletely and inaccurately identifying what jobs can be solved using IT applications.	Being unable to identify what jobs can be solved using IT applications.
7	Completely and accurately selecting the appropriately IT applications to solve a specific task.	Nearly completely and accurately selecting the appropriately IT applications to solve a specific task.	Incompletely and inaccurately selecting the appropriately IT applications to solve a specific task.	Being unable to select the appropriately IT applications to solve a specific task.
8	Offering opportunities to apply IT in solving specific tasks; having a complete assessment of the effectiveness and feasibility of such opportunities.	Offering opportunities to apply IT in solving specific tasks; having a part of assessment of the effectiveness and feasibility of such opportunities.	Offering opportunities to apply IT in solving specific tasks; having no assessment of the effectiveness and feasibility of such opportunities.	Being unable to offer opportunities to apply IT in solving specific tasks.

Table 6. Expression levels of competence of using machines and technical means

Criteria	Level of expression			
	4	3	2	1
9	Have a complete and accurate understanding of the structure and maintenance of equipment such as computers, automatic controlling systems, measuring devices, remote monitoring devices.	Have a relatively complete and accurate understanding of the structure and maintenance of equipment such as computers, automatic controlling systems, measuring devices, remote monitoring devices.	Have an incomplete and inaccurate understanding of the structure and maintenance of equipment such as computers, automatic controlling systems, measuring devices, remote monitoring devices.	Have no understanding of the structure and maintenance of equipment such as computers, automatic controlling systems, measuring devices, remote monitoring devices.
10	Having proficient skills in using computers and smart agricultural equipment.	Having nearly proficient skills in using computers and smart agricultural equipment.	Being confused when using computers and smart agricultural equipment.	Being unable to use computers and smart agricultural equipment.

Table 7. Expression levels of competence of applying software

Criteria	Level of expression			
	4	3	2	1
11	Proficiently using utility software on the operating system and basic office software to solve specific tasks.	Nearly proficiently using utility software on the operating system and basic office software to solve specific tasks.	Being confused when using utility software on the operating system and basic office software to solve specific tasks.	Being unable utility software on the operating system and basic office software to solve specific tasks.
12	Proficiently using commercial software, automatic controlling software, and remote monitoring.	Relatively proficiently using commercial software, automatic controlling software, and remote monitoring.	Being confused when using commercial software, automatic controlling software, and remote monitoring.	Being unable to use commercial software, automatic controlling software, and remote monitoring.
13	Proficiently using specialized software for statistics, data processing, market analysis, and index calculation.	Relatively proficiently using specialized software for statistics, data processing, market analysis, and index calculation.	Being confused when using specialized software for statistics, data processing, market analysis, and index calculation.	Being unable to use specialized software for statistics, data processing, market analysis, and index calculation.
14	Proficiently performing the following operations: Building, updating and managing specialized databases.	Relatively proficiently performing the following operations: Building, updating and managing specialized databases.	Being confused when performing the following operations: Building, updating and managing specialized databases.	Being unable to perform the following operations: Building, updating and managing specialized databases.
15	Using software on GIS, remote sensing to solve problems in the agricultural field with high efficiency.	Using software on GIS, remote sensing to solve problems in the agricultural field with relatively high efficiency.	Using software on GIS, remote sensing to solve problems in the agricultural field without high efficiency.	Being unable to use software on GIS, remote sensing to solve problems in the agricultural field.
16	Applying blockchain technology and forms of e-commerce in production and business with high efficiency.	Applying blockchain technology and forms of e-commerce in production and business with relatively high efficiency.	Applying blockchain technology and forms of e-commerce in production and business without high efficiency.	Being unable to apply blockchain technology and forms of e-commerce in production and business.

Table 8. Expression levels of competence of professional development

Criteria	Level of expression			
	4	3	2	1
17	Actively self-studying, coming up with innovative and creative ideas. Participating in professional capacity building regularly.	Actively self-studying, coming up with innovative and creative ideas. Participating in professional capacity building quite regularly.	Actively self-studying, but being unable to come up with innovative and creative ideas. Participating in professional capacity building quite regularly.	Not actively self-studying, not coming up with innovative and creative ideas. Not participating in professional capacity building regularly.
18	Regularly researching and updating new trends in the area of expertise. Having an in-depth assessment of the effectiveness and inadequacy of such trends.	Regularly researching and updating new trends in the area of expertise. Having some assessments of the effectiveness and inadequacy of such trends.	Irregularly researching and updating new trends in the area of expertise. Rarely having an in-depth assessment of the effectiveness and inadequacy of such trends.	Not researching and updating new trends in the area of expertise.
19	Proactively proposing appropriate IT application solutions, bringing out high quality and efficiency in work.	Proactively proposing appropriate IT application solutions, bringing out relatively high quality and efficiency in work.	Proposing appropriate IT application solutions, but not bringing out high quality and efficiency in work.	Not proposing appropriate IT application solutions.

Table 9. Expression levels of competence of socializing

Criteria	Level of expression			
	4	3	2	1
20	Having proficient skills in communication and cooperation using technology in the media	Having relatively proficient skills in communication and cooperation using technology in the media	Having inefficient skills in communication and cooperation using technology in the media	Having no skills in communication and cooperation using technology in the media
21	Making good use of the rules of conduct in the digital environment to have appropriate awareness and responses.	Making quite good use of the rules of conduct in the digital environment to have appropriate awareness and responses.	Being confused when making good use of the rules of conduct in the digital environment to have appropriate awareness and responses.	Being unable to make good use of the rules of conduct in the digital environment to have appropriate awareness and responses.

In the step of testing the competence framework, researchers conducted a survey for three students: i) Students at the beginning of the first year (who have not studied informatics at the university); ii) Students who are studying in year 3 (who have just finished studying informatics); and iii) Students preparing to graduate. The aim of this survey is to assess the reliability of the competency framework and the growth of students' IT application skills during university education. The survey results are presented in Figure 2.

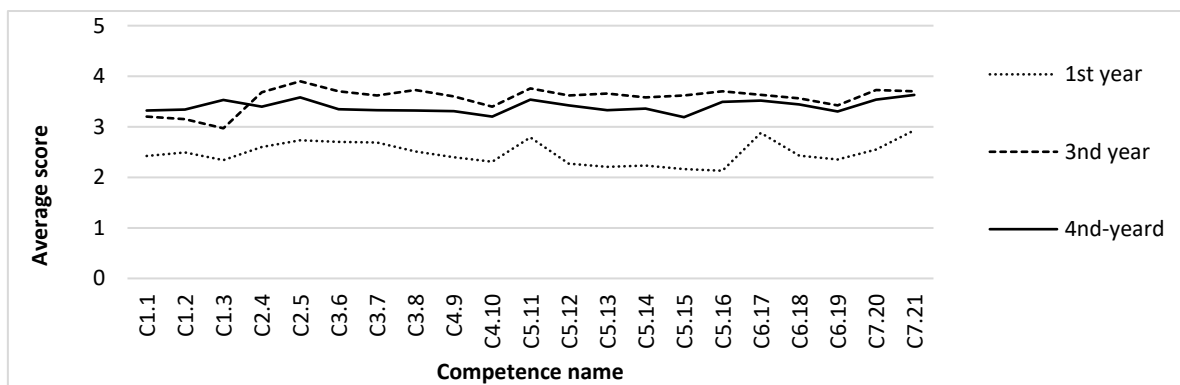


Figure 2. Levels of competence achieved by different groups of students

Figure 2 shows that the level of achievement of the competence criteria of students after studying informatics is higher than before studying. However, the level of achievement when having just finished studying subjects on Informatics is almost higher than when preparing to graduate. To verify the results, we make another comparison of the output standard test scores of students. At TUAF, one of the requirements for students to be considered for graduation is to meet the output standards in informatics. This exam is similar to the content of the general informatics subject that students have studied in the second semester of the first year. From the 2nd year onwards, students can participate in the output standard assessment exam.

Therefore, we make comparison score of 154 students who took the exam in the 2nd year (DT1) and 219 students who took the exam when they were going to be considered for graduation (DT2) [31]. Figure 3 shows the statistical results from seven rounds of output standard exams from March 2021 to August 2022.

In Figure 3, the level of failure of DT1 is only half of that of DT2 and the level of achievement of DT1 is much higher than that of DT2. In particular, compared to the theoretical score, the score of the practical test has a rather high difference between the two subjects. This result shows the reasonableness of the survey results obtained, and also shows that one of the remaining problems in the training in informatics at TUAF is the irregular training leading to output quality is degraded. This finding is one of the bases for us to suggest measures to improve training quality in future studies.

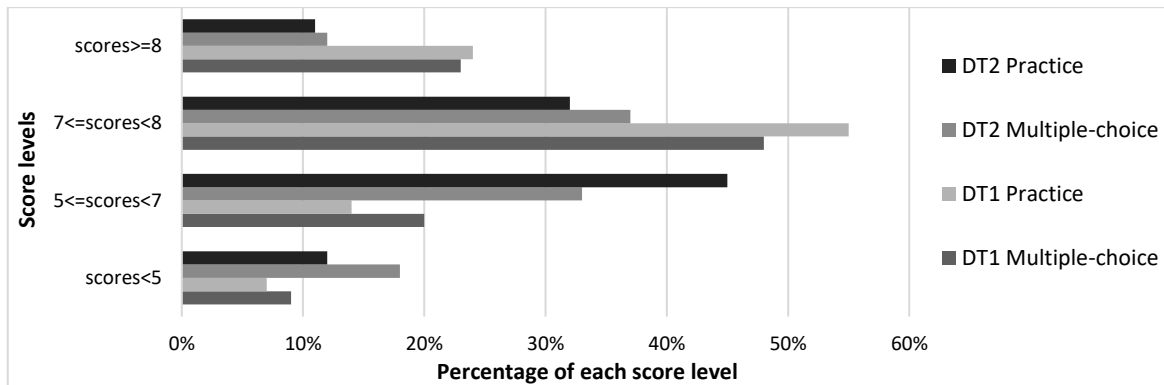


Figure 3. The comparison of theoretical and practical scores between two groups of students

3.3. Using the competence framework in teaching informatics for students of agriculture and forestry

The development of a competence framework plays an important role in the process of teaching informatics for students in agriculture and forestry because the competence framework is an important reference for training institutions in the process of program development in order to provide output standards suitable to the needs of the actual profession. The competence framework orients learners on the requirements to be achieved. From there, helping learners to actively develop their own learning and training plans during the training process. The competence framework is the basis for lecturers to develop appropriate content, teaching methods and assessment. Active teaching methods are appropriate in competence development teaching to improve students’ ability to apply knowledge into practice [32]. For the test and assessment, teachers can design tools, such as rubric and self-assessment, applying situations, question types to assess the level of awareness and self-assessment skills and application competence of students [33]. Table 10 presents examples of applying the competence framework in teaching general informatics.

Table 10. Using the competence framework in teaching general informatics

Content	Competence to be developed	Teaching method	Assessing method
Application of IT in areas of expertise	C1.1, C1.2, C3, C6	Students already have a certain understanding of these contents, so teachers can use the group discussion method to collect ideas after the process of exchanging and discussing among group members.	Peer assessment sheet; product review sheet.
Operating system	C5.11, C3, C6		
Laws in the use of IT	C7.3, C7.21, C3, C6	There are many real-life situations that students have encountered related to issues of copyright, plagiarism and regulations related to IT. Therefore, the role-playing method can be used to help students grasp knowledge and better handle situations, and at the same time practice living and working in compliance with the law.	Product evaluation sheet; multiple choice test.
Basic information security issues	C2.4, C3, C6	Contextual teaching can be used with situations that are real-life problems or students’ future careers to help students recognize the meaning of learning and the relationship between the subject and reality.	Checklist; Rating scale; Criteria rating sheet
Computer skills	C4.9, C4.10, C3, C6		
Searching for information on the internet	C2, C3, C6	Teaching these two contents together uses problem-solving and contextual teaching methods, and tests and assessments through project-based exercises.	Peer assessment sheet; product evaluation sheet; practice test questions
Microsoft Office Software	C5.11, C7.20, C3, C6		
Forms of electronic communication	C5.16, C7.20, C3, C6		

The content in Table 10 was built based on the detailed outline of the General Informatics subject and the competency framework [34]. Using the competency framework in teaching will help us to adjust the subject content to match the output standards. Moreover, teaching associated with capacity development will allow teachers to be more creative in innovating teaching methods and improve students' ability to apply knowledge in professional practice. This is the goal towards higher education today.

4. CONCLUSION

With a view to build a competence framework to serve the training of informatics for students in the field of agriculture and forestry, the article has introduced the concept and characteristics of students' competence to apply information technology in this field; built a competence framework with specific criteria and expressions and how to use the competence framework in teaching informatics. The Competence Framework is really necessary in training in general and in renewing teaching methods in particular in order to develop professional competence for students, to meet the change in today's digital agriculture. This is a specific competence framework for students of agriculture and forestry as there has not been any previous research on this issue. Therefore, in the future, we will conduct a survey on a broader scale, with students in different areas to confirm the reasonableness of the competence framework and possibly make timely adjustments in order to come up with a competence framework that best suits the characteristics of the industry. Besides, we will apply the competence framework in the process of teaching informatics to evaluate the effectiveness and urgency of using them in training at TUAF currently.




REFERENCES

- [1] M. Keller, M. Rosenberg, M. Brettel, and N. Friederichsen, "How virtualization, decentrazliation and network building change the manufacturing landscape: An industry 4.0 perspective," *International Journal of Mechanical, Aerospace, Industrial, Mechatronic and Manufacturing Engineering*, vol. 8, no. 1, pp. 37–44, 2014.
- [2] United Nations Asian and Pacific Training Centre for Information and Communication Technology for Development (UN-APCICT/ESCAP), "Briefing on ICT Competency Standards," 2016.
- [3] UNESCO, "UNESCO's ICT competency framework for teachers," 2023. [Online]. Available: <https://www.unesco.org/en/digital-competencies-skills/ict-cft> (accessed Feb. 19, 2023).
- [4] T. C. Phan, T. T. Ngo, and T. M. Phan, "Assessment of information technology use competence for teachers: Identifying and applying the information technology competence framework in online teaching," *Journal of Technical Education and Training*, vol. 12, no. 1 Special Issue, pp. 149–162, 2020, doi: 10.30880/jtet.2020.12.01.016.
- [5] R. Senik and M. Broad, "Information technology skills development for accounting graduates: Intervening conditions," *International Education Studies*, vol. 4, no. 2, May 2011, doi: 10.5539/ies.v4n2p105.
- [6] S. M. Mutula and P. Van Brakel, "ICT skills readiness for the emerging global digital economy among small businesses in developing countries," *Library Hi Tech*, vol. 25, no. 2, pp. 231–245, Jun. 2007, doi: 10.1108/07378830710754992.
- [7] T. V. Dube, "Information technology skills and competencies for academic library staff," in *Handbook of Research on Records and Information Management Strategies for Enhanced Knowledge Coordination*, IGI Global, 2021, pp. 306–315.
- [8] C. Hewagamage and K. P. Hewagamage, "A framework for enhancing ICT competency of universities in Sri Lanka," *International Journal of Emerging Technologies in Learning*, vol. 10, no. 5, pp. 45–51, 2015, doi: 10.3991/ijet.v10i5.4802.
- [9] M. Ahmad, A. A. Karim, R. Din, and I. S. M. A. Albakri, "Assessing ICT competencies among postgraduate students based on the 21st Century ICT Competency Model," *Asian Social Science*, vol. 9, no. 16, pp. 32–39, 2013, doi: 10.5539/ass.v9n16p32.
- [10] Ministry of Information and Communications of Vietnam. Regulations on skills standards for using information technology (in Vietnamese). *Circulars 03/2014/TTTT-BTTTT*, 2014. [Online]. Available: <https://vbpl.vn/bothongtin/Pages/vbqpq-toanvan.aspx?ItemID=35290&dvid=322> (accessed Feb. 19, 2023).
- [11] N. T. Dai and N. T. Hao, "Proposing a digital competence framework for teachers at the Vietnam National University Ho Chi Minh City," *Science and Technology Development Journal - Social Sciences & Humanities*, vol. 5, no. 4, pp. 1385–1396, Jun. 2021, doi: <https://doi.org/10.32508/stdjssh.v5i4.653>.
- [12] A. T. Mai, N. T. Huynh, and A. T. Ngo, "Digital competence framework for higher education students: suggesting approach derived from relevant publications to vietnamese institutions," *Journal of Technical Education Science*, vol. 66, no. 66, pp. 101–111, 2021, doi: 10.54644/jte.66.2021.1072.
- [13] L. T. K. Loan, "Developing information technology capacity in teaching for pedagogical students at university," Ph.D. dissertation, Hanoi National University of Education, 2019.
- [14] T. H. Minh and T. Van Bieu, "Designing ict competence framework for Chemistry pre-service teachers," *Ho Chi Minh City University of Education Journal of Science*, vol. 85, pp. 63–73, 2016.
- [15] N. T. Dung, "Interactive teaching according to competency approach in B-learning for students of Informatics pedagogy," Ph.D. dissertation, Ha Noi University of Science and Technology, 2018.
- [16] L. T. Tran, N. T. H. Ngo, H. T. M. Nguyen, T. T. T. Le, and T. T. H. Ho, "'Employability in context': graduate employability attributes expected by employers in regional Vietnam and implications for career guidance," *International Journal for Educational and Vocational Guidance*, pp. 3–19, 2022, doi: 10.1007/s10775-022-09560-0.
- [17] H. T. Toan and T. T. Hai, "Current status of the job competencies of students at the university of Agriculture and Forestry, Thai Nguyen university," in *Proceedings of the 2nd international conference on innovation in learning instruction and teacher education – ilite2*, 2021, pp. 312–325.
- [18] J. W. Creswell and V. L. P. Clark, *Designing and Conducting Mixed Methods Research*. SAGE Publications, 2017.
- [19] F. I. E. Rusly and R. A. Erlangga, "Development of video-based on contextual teaching and learning electric energy subtheme," *MUDARRISA: Jurnal Kajian Pendidikan Islam*, vol. 12, no. 1, pp. 86–101, 2020, doi: 10.18326/mdr.v12i1.86-101.
- [20] Thainguyn University Agriculture and Forestry, "Mission, vision and core values," 2020. [Online]. Available: <https://en.tuaf.edu.vn/bai-viet/tuaf-mission-and-vision-6823.html> (accessed Feb. 19, 2023).




- [21] T. Haigh, "The history of information technology," *Annual Review of Information Science and Technology*, vol. 45, no. 1, pp. 431–487, 2011, doi: 10.1002/aris.2011.1440450116.
- [22] J. C. Burgelman, *How social dynamics influence information society technology: Lessons for innovation policy*. OECD Publishing, 2001.
- [23] Information Technology Association of America, *Bridging the gap: Information technology skills for a new millennium*. Information Technology Association of America, 2000.
- [24] The National Assembly of The Socialist Republic of Vietnam. Law No. 67/2006/QH11 of the National Assembly: Law on Information Technology. 2006. [Online]. Available: <https://chinhphu.vn/default.aspx?pageid=27160&docid=29137>.
- [25] Ministry of Education and Training of Vietnam, "General Education Program 2018." 2018. [Online]. Available: <https://moet.gov.vn/tintuc/Pages/CT-GDPT-Tong-The.aspx> (accessed Feb. 19, 2023).
- [26] Ministry of Agriculture and Rural Development, "Regulations on codes, professional title standards and salary rankings for officials specializing in agricultural extension and forest management and protection." Circular No. 18/2020/TT-BNNPTNT, 2020. [Online]. Available: <https://vanban.chinhphu.vn/default.aspx?pageid=27160&docid=202248>.
- [27] Thainguyen University Agriculture and Forestry, "Recruiting businesses," 2020. [Online]. Available: https://cuusinhvien.tuaf.edu.vn/index.php?com=news&id_cate=47 (accessed Feb. 19, 2023).
- [28] Thainguyen University Agriculture and Forestry, "Formal university training programs," 2020. [Online]. Available: <https://tuaf.edu.vn/danh-sach-bai-viet/chuong-trinh-dao-tao-278.html> (accessed Feb. 19, 2023).
- [29] Vietnam National University of Agriculture, "Formal university training programs," 2021. [Online]. Available: <https://www.vnua.edu.vn/dao-tao/chuong-trinh-dao-tao/dao-tao-dai-hoc> (accessed Feb. 19, 2023).
- [30] Hue University of Agriculture and Forestry, "Formal university training programs," 2021. [Online]. Available: <http://daotao.huaf.edu.vn/index.php?language=vi&nv=news&op=Dai-hoc-Cao-dang-Lien-thong> (accessed Feb. 19, 2023).
- [31] Thainguyen University Agriculture and Forestry, "Output standard examination results," 2020. [Online]. Available: <https://cfi.tuaf.edu.vn/danh-sach-bai-viet/chuan-dau-ra-nth-222.html> (accessed Feb. 19, 2023).
- [32] X. Yang and P. Chen, "Applying Active Learning Strategies to Develop the Professional Teaching Competency of Chinese College Student Teachers in the Context of Geography Education," *International Journal of Learning, Teaching and Educational Research*, vol. 21, no. 7, pp. 178–196, 2022, doi: 10.26803/ijlter.21.7.10.
- [33] V. Shankaraman and J. Ducrot, "Leveraging competency framework to improve teaching and learning: A methodological approach," *Education and Information Technologies*, vol. 21, no. 5, pp. 1299–1327, 2016, doi: 10.1007/s10639-015-9383-7.
- [34] Thainguyen University Agriculture and Forestry, "Detailed description of the General Informatics course," 2021. [Online]. Available: <https://cfi.tuaf.edu.vn/bai-viet/de-cuong-chi-tiet-hoc-phan-tin-hoc-12129.html> (accessed Feb. 19, 2023).

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