Strategies for Talent's Digital Competence Development at Higher Vocational Colleges for Digital Transformation

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Abstract: Digital transformation has brought unprecedented opportunities and challenges to economic and social development, and the development of talent's digital competence is of growing importance. Under an ideal situation, *digitization*, *digitalization* and *digital transformation* are three stages of gradual digital development. However, influenced by the difference in social and economic development among regions, higher vocational colleges, as an educational system closest to the labor market, vary by their own strengths and digital competence. From the perspective of game theory and based on the model of boxed pig game, this paper provides strategies and suggestions for the cultivation of talent's digital competence in terms of non-cooperative strategy at higher vocational colleges. The supply-demand model of talent's digital competence cultivation is established to provide further suggestions for the top-down *cooperation* strategy among higher vocational colleges.

Keywords: digital transformation, higher vocational colleges, digital competence, game theory, model of boxed pig game, talent cultivation

As an educational system closest to the labor market, vocational education plays an important role in society and acts as an important export of social labor that supports economic development (Sgarzi, 2021; Abdullah et el., 2019). The talent cultivated by vocational education should not only be able to solve practical problems, but also have sufficient ability to meet future challenges. However, with the further development of digital transformation, practical problems and future challenges faced by vocational education are unprecedented and unpredictable. To have more adequate preparation and quicker response than in the past, higher vocational colleges need to focus on the cultivation of talent's digital competence. Affected by the difference in social and economic development, digital transformation in different regions has not typically developed in a synchronized fashion. However, it is the responsibility and obligation of higher vocational colleges to provide the labor market with talent suitable for digital transformation and to meet the new needs of *Industry 4.0*, the digital economy, and society. Therefore, how vocational colleges in various stages of digital transformation develop and cultivate talent's digital competence correspondingly is particularly crucial.

1. Basic principles for higher vocational colleges to deal with digital transformation

(1) Three stages of digital transformation

Digital transformation refers to a series of impacts that arise from the process of digitalization. To have a clear understanding of digital transformation, it's necessary to understand the connection and differences among the three concepts of digitization, digitalization, and digital transformation.

Digitization, which describes the conversion of analog and physical information into digital formats, refers to the transformation of disseminated information into digital formats. For example, the conversion of printed books into electronic format and the electronic version of printed documents can be considered digitization (ILO, 2020). Faculty members at higher vocational colleges convert teaching materials into digital formats, such as documents and videos, which is also digitization.

Digitalization is the digitization of work processes and can be understood as a process of using digital technology and information to change the operation of individual institutions(Kao & Chueh, 2022). For example, before digitalization, an operation flow involves a series of manual counter processes from the *face-to-face submission of a printed application* to *confirmation of the printed application.*

After digitalization, the counter operation is not required, and the entire series of processes can be converted to a remote operation by using digital technology equipment. Digitalization is based on digitization, which serves as digital information (Kraus et al., 2021). Meanwhile, digitalization also needs to be supported by the corresponding digital technology. The deployment and transformation of a series of digital technologies from financial systems to educational administration systems in higher vocational colleges is a process that promotes the digitalization of various businesses at colleges. In the past, according to the requirements of face-to-face teaching, students were required to read and study printed textbooks and submit paper-based homework. Teachers were then required to give paper-based evaluations and feedback. Today, these series of operations can be converted to run on an online platform, which aptly demonstrates the progress of digitalization.

Digital transformation, based on digitization and digitalization, is related to the profound and coordinated transformation of converting culture, labor, and technology (Tursunbayeva et al., 2020). Correspondingly, the demand for talent's capabilities at various business ports is further related to their digital skills. The series of impacts resulting from digital development can change the operations, strategic directions, and values of an organization.

In an ideal state, there are three stages of digital development, progressing from digitization, digitalization, to digital transformation. However, due to the influence of national conditions and the uneven development among regions, diverse regions usually promote digital innovations in some organic and special manner. Therefore, these three stages often overlap (Chen et al., 2021; Didier, 2022).

(2) Talent is the key to digital transformation

The three areas of digital transformation that require attention are *business transformation*, *technological transformation*, and *organizational transformation* (Li, et al., 2021).

The three central elements for analyzing digital transformation in educational institutions are *people*, *site/scenario*, and *process*. *People* here refers to the transformation of knowledge and competence. *Site/scenario* refers to the transformation of institutional venues and basic facilities, while *process* refers to the transformation of teaching, learning, and scientific research.

Driven by technological transformation, resources, data, and content can be shared, open to the public, and become transparent (Dunlap, 2008). This further promotes the scenario and process transformation of cooperation and communication between people, to promote *business transformation*. Simultaneously, as the demands for *people* and management are required to be transformed, the organizational structure, operating mechanism, needs for talent, and organizational culture will change accordingly, and top-down changes will naturally occur to promote *organizational transformation* (Sofkova Hashemi & Cederlund, 2017).

It is discernible that digital transformation represents the digital changes of organizational strategies, business processes, products, and platforms at all levels within an organization, and what institutions need are digital transformations of organization, culture, and thinking.

The focus of digital transformation is not merely on the transformation of *technology*, but also on the transformation of *people* (Hatzigianni, 2018). For higher vocational colleges to adapt to the digital future, the support of technology is only a starting point. The key lies in whether they can develop next-generation technologies, the ability to narrow the talent pool gap, and the expertise to sustainably develop talent (Khan et al., 2022). Therefore, the goal of digital transformation lies in the transformation of talent, and the key lies in the transformation of talent development programs.

(3) The challenges of digital transformation in developing digital competence of talent

The old view, that academic-oriented education should focus on the cultivation of students' knowledge, and vocational education should focus on the inheritance and development of skills, are no longer able to meet today's requirements (Cone et al., 2022). With the impact of digital transformation, academic-oriented education has gradually become directly related to the labor market. Meanwhile, vocational education, which used to only focus on skills development, should go beyond simply developing students' technical know-how and abilities.

Driven by digital transformation, the professional world has changed significantly, and digital competence has become fundamental as required in the modern workplace. Employees not only need digital capabilities to deal with new technologies in the business process but also sustainable development capabilities to keep up with rapidly evolving technological iterations (Priem & Fendler, 2019). However, the supply and demand for digitally capable talent are unbalanced in the current market. As a result of the influence of COVID-19, the shortage of talent with digital competence has become more prominent. In order to meet the challenges brought by this digital transformation, the key breakthrough lies in the cultivation of talent to achieve greater digital competence.

2. The current situation of talent's digital competence development at higher vocational colleges under digital transformation

(1) Talent cultivation driven by market demand involves many stakeholders

As mentioned above, digital transformation is a profound and coordinated process related to the transformation of converting culture, labor, and technology. Therefore, in one system it involves upgrades and transformation of all business ports of an entire organization. In a social system, it involves systematic shifts in many aspects, including the economy, culture, and labor market. Therefore, many stakeholders are involved.

In addition, as talent is cultivated by higher vocational colleges to directly orient them to the labor market, the complex interaction between many stakeholders and institutions is the most critical feature of the higher vocational college system. Stakeholders, involved in this complex relationship, include educational and other training institutions, local authorities, industry groups, employers, ministries, standard-setting authorities, trade unions, employment services and others, which cover a wide range of the economy. It, therefore, embodies the important role of reliable and coordinated cooperation and communication to ensure effective talent cultivation. In general, all stakeholders can be divided into three levels (Sgarzi, 2021): government departments, statutory organizations, or institutions. These typically belong to first-level stakeholders. Second-level stakeholders include trade unions, research institutes, teacher associations, NGOs. Vocational and technical educational institutions, companies, and other training institutions related to vocational and technical education are the third-level stakeholders. The first-level stakeholders predominantly play a governance role in talent cultivation. They can authorize collective actions and have statutory responsibilities in the governance process. Stakeholders at the second level mostly play an advocacy role. They include chambers of commerce, trade unions, and other departments directly related to economic activities, as well as non-governmental organizations and relevant departments engaged in research activities. Third-level stakeholders are at the forefront of the education field and as the implementers of vocational college courses, need to provide timely, relevant, and high-quality talent cultivation programs according to the needs of society and the labor market.

(2) Digital transformation empowers the efficiency of talent's digital competence cultivation in higher vocational colleges

In the information age, combined with the support of information technology, the connection between individuals became closer. Both competition and cooperation emerged. With the arrival of the digital age, new-generation information technologies, such as cloud computing, big data, the Internet of Things, mobile Internet of Things, and artificial intelligence, have been popularized and utilized. Social communication methods have undergone revolutionary changes. Physical reality and digital virtuality are now highly integrated, which has extended communications and cooperation to virtual space and further enhanced the integration (Manchester & Facer,

2015). From another perspective, it is under the empowerment of digital transformation that the interaction and sharing among individuals, organizations and even the public can improve the efficiency of the workforce and the public's quality of life. At the same time, digital transformation has actively empowered higher vocational colleges to be more efficient in the process of cultivating talent's digital competence.

Recognition has come illustrating that digital competence plays a critical role in meeting the demands of *Industry 4.0*, and the new demands of the digital economy and society have been accomplished. As importance is attached to digital transformation, numerous practices, and additional research regarding how to better encourage digital competence have been conducted. Due to the wide range of majors at higher vocational colleges, the demand for digital competence is correspondingly extensive (Ali Asadullah, 2019). Therefore, in view of the broad directions of digital competence cultivation, and in order to better help colleges and universities cultivate digital talent, organizations and institutions in different countries have proposed a variety of frameworks and levels for talent's digital competence cultivation.

The Essential Digital Skills Framework, proposed in 2018 by the UK government, is based on a study of 9,000 respondents and was updated in 2019 (GOV.UK, 2019). In the *2019 Digital Commerce Global Standards Report*, the Digital Intelligence Institute from Singapore launched *A Common Framework for Digital Literacy, Skills, and Readiness,* which covers eight fields (Digital Intelligence Institute, 2019). The five competencies were further enriched in the latest edition of the *Digital Competence Framework for Citizens (DigComp)*, proposed by the European Commission in 2022 (Vuorikari et al., 2022). In its *Digital Skills Insights 2021*, the International Telecommunication Union identified three levels of digital skills required for digital transformation, namely, basic, intermediate, and advanced levels (ITU, 2021). These competency frameworks and levels serve as an important reference for educational institutions at all levels of talent cultivation, meet current and future needs, and are highly targeted with clear purposes. From another perspective, driven by digital transformation, various frameworks and levels have been proposed to improve the efficiency of talent's digital competence cultivation at higher vocational colleges.

Additionally, digital transformation is further strengthening the interaction in talent cultivation and the sharing of information among higher vocational colleges. This has created complementary advantages and improved the efficiency of talent cultivation (Jules, 2015). Collegiate and university talent cultivation has shown a trend of competence cultivation-orientation, and academic institutions have further focused on cultivating competitive capabilities based on their own advantages and the needs of the industry (Matsumoto, 2018). For example, under the influence of digital transformation, polytechnics should cultivate talent with advanced digital skills and enable students to create innovation and write programs (Ochieng & Ngware, 2021). Business schools, on the other hand, differ from polytechnics in their goals and strategies for talent development, and they focus on cultivating talent who can improve business models and empower digital skills (Adeniyi et al., 2022). Affected by digital transformation and in the context of information exchange and sharing, colleges and universities should synergistically adapt their respective advantages in complementary ways to each other. Well-directed efforts in this area will more effectively cultivate talent needed by industries resulting in stronger output and non-redundancy, so as to further improve the efficacy of talent's digital competence cultivation.

(3) The supply of talent's digital competence has been caught in a predicament of the boxed pig game model

Technological transformation is one of the three major areas of digital transformation. The degree of digital technology transformation can affect the overall development of digital transformation. Economic strength affects the digital technology deployment of hardware, software, and scientific research output in organizations and institutions, which has had a profound and lasting impact on the subsequent development of digital transformation (Manchester & Facer, 2015).

Presently, due to the uneven social and economic development among countries and regions, the digital transformation of organizations and institutions in divergent regions varies in stages. Conventionally, to meet the market demand for talent, each higher vocational college has a common and inescapable responsibility and obligation for talent supply. However, the impact of uneven economic development has led to a variance in digital transformation at higher vocational colleges, thus resulting in the inconsistent cultivation of talent's digital competence. In this case, higher vocational colleges will fall into the Nash equilibrium of the economics' *boxed pig game* during talent cultivation.

The theory assumes that a big pig and a small pig live in a pigsty. There is a trough on one side of the pigsty and a button to control the food on the other side. Every time the button is pressed, 10 units of food will fall into the trough. Regardless of whether it is a big pig or a small pig, one of them needs to press the button from one side of the pigsty, and then go to the trough on the other side to enjoy the food. Therefore, the pig who presses the button needs to pay a cost of 2 units of food. Based on their eating speed, if the small pig presses the button and then runs to the trough, the big pig can eat 9 units of food, and the small pig coming later can only eat the remaining 1 unit

of food. If two pigs press the button at the same time and then run to the trough, the big pig can eat 7 units, and the small pig can eat 3 units. If the big pig presses the button and then runs to the trough, the small pig can eat 4 units of food, and the big pig coming later can eat 6 units of food. If both pigs do not press the button, they get nothing. The table below shows the benefits for both the big pig and the small pig, after subtracting the 2-unit-food cost of pressing the button (Orsini et al., 2005). Because both pigs can analyze the situation rationally, the big pig will choose to take the initiative to press the button, and the small pig will stay near the trough and wait for food (Hung, 2016).

Table 1 Boxed Pig Game

Big pig	Small pig		
		Presses the button	Does not press the button
	Presses the button	5, 1	**4,4**
	Does not press the button	9, -1	0,0

There are several conditions for the effectiveness of the boxed pig game model (Orsini er al., 2005). First, the big pig is stronger than the small pig, just as higher vocational colleges vary by their own strengths. Second, the behaviors of both the big pig and small pig are autonomous; this is the same as the behaviors of higher vocational colleges in talent cultivation because stronger higher vocational colleges cannot force weaker higher vocational colleges to do a certain task. Third, both the big pig and small pig can analyze rationally, just like all higher vocational colleges have the ability to make rational analyses in talent cultivation, familiarize themselves with their own characteristics and advantages, and reasonably analyze the benefits of talent cultivation.

Affected by the difference in stages of digital transformation, higher vocational colleges are still unable to develop cooperation in talent cultivation through the model of sharing. Based on the theoretical analysis of the boxed pig game model, stronger vocational colleges will independently assume the task of supplying digital talent, while weaker vocational colleges will choose to quietly quit the competition in the cultivation of digital talent, which further affects the balance of talent development.

3. Break the deadlock - strategies for the cultivation of talent's digital competence at higher vocational colleges under digital transformation

The conceptual meanings of *cooperation* and *non-cooperation* are based on game theory (Wang & Huang, 2021). *Cooperation* refers to the binding cooperation between higher vocational colleges with respect to talent cultivation. *Non-cooperation* refers to the non-binding cooperation between higher vocational colleges on the cultivation of talent.

(1) Non-cooperative strategy based on the model of the boxed pig game among higher vocational colleges

At present, the conditions for the development of non-cooperative strategies among higher vocational colleges to cultivate talent's digital competence are as follows: Condition ① The needs of the demander are clear, and the information has been shared. Condition ② Talent cultivation is efficiency-oriented under the influence of digital transformation.

In the model of the boxed pig game, the amount of food dropped into the trough by pressing the button once is known, and the amount of food taken and consumed by the big pig and the small pig is also known. The information is shared, which meets the above-mentioned Condition ① for the non-cooperative strategy of cultivating talent's digital competence among higher vocational colleges. The purpose of the big pig and the small pig is how to efficiently satisfy their appetites with an optimal strategy, which meets the above-mentioned Condition ②.

In the game of talent's digital competence cultivation between stronger vocational colleges (hereinafter referred to as the *Stronger*) and weaker higher vocational colleges (hereinafter referred to as the *Weaker*), it is assumed that the higher vocational college as the supplier institutions that carry out the cultivation of talent's digital competency can provide 10 units of social benefits to the demander. In addition, the higher vocational colleges that take the initiative to shoulder the task of talent's digital competence cultivation need to pay the cost of 2 units of social benefits.

Non-cooperative Strategy 1: If the Weaker and the Stronger actively cultivate talent's digital competence, it will cost 4 units of social benefits at the same time. The social benefit generated by the Weaker is only 1 unit. This strategy can bring 6 units of social benefits to the demander.

Non-cooperative Strategy 2: If the Weaker actively implements the talent cultivation first, and the Stronger passively follows suit, the weaker will end in an arduous but fruitless task due to the difference in their own strengths. It will not produce any positive social benefits; instead, it will cost 1 unit, while the Stronger, with the help of its own strength, will be able to carry out the cultivation of talent's digital competence with a better reputation and method after the practice of the Weaker. The Stronger produces 9 units of social benefits, but the Weaker loses 1 unit. Therefore, this strategy brings 8 units of social benefits in total.

Non-cooperative Strategy 3: If the Stronger takes the lead in actively cultivating talent's digital competence and the Weaker then follows suit in an auxiliary and supplementary manner based on practical guidance from the Stronger, both the Stronger and the Weaker will produce 4 units of social benefits, thus bringing 8 units of social benefits in total to the demander.

Non-cooperative Strategy 4: This strategy means that neither party actively initiates the cultivation of talent's digital competence. Neither party can generate social benefits, nor can they provide any social benefits to the demander.

Table 2 Game between stronger and weaker higher vocational colleges

		Weaker higher vocational colleges	
		actively cultivating the talent's digital competence	passively cultivating the talent's digital competence
Stronger higher vocational colleges	actively cultivating the talent's digital competence	5,1 (Non-cooperative Strategy 1)	4,4 (Non-cooperative Strategy 3)
	passively cultivating the talent's digital competence	9,-1 (Non-cooperative Strategy 2)	0,0 (Non-cooperative Strategy 4)

It can be seen from the above table that although both Non-cooperative Strategy 2 and Non-cooperative Strategy 3 can provide 8 units of social benefits to the demander, in Non-cooperative Strategy 2, there is a huge difference between what the Weaker costs and the Stronger benefits. For the Weaker, the loss outweighs the gain. Therefore, it is encouraged to take Non-cooperative Strategy 3 to guide the talent cultivation of higher vocational colleges. Specifically, the stronger higher vocational colleges should take the lead in developing talent's digital competence and then drive and guide the weaker vocational colleges to carry out talent cultivation programs, thus realizing the balanced development of talent cultivation under a win-win situation and producing more efficient and effective social benefits.

(2) Top-down cooperation strategies among higher vocational colleges

After the critical role of digitally capable talent in digital transformation has been well understood, the significant question becomes, how can we efficiently supply the labor market with digitally-adapted talent?

There are three elements of digital transformation: digital innovation, digital adaptation, and digital acceleration (ILO, 2020). *Digital innovation* refers to the innovation of teaching methods and technology brought by digital technology. *Digital adaptation* means that the development of new competencies is to adapt to the changing technological demands of society and the labor market. *Digital acceleration* refers to the promotion of relevant policies due to the development of technology. Because of the development of digital technology, innovations and changes must be made in the cultivation of talent's digital competence, teaching methods, and policies. Among them, policy changes that adapt to digital transformation are particularly important. This is because top-down transformation is the key to *business transformation*, *technological transformation* and *organizational transformation* in the process of digital transformation.

Figure 1 shows a supply-demand equilibrium model among the first-, second-, and third-level stakeholders in the cultivation of talent's digital competence. The first- and second-level stakeholders are the demanders of competencies, and the third-level stakeholders are the suppliers of competencies.
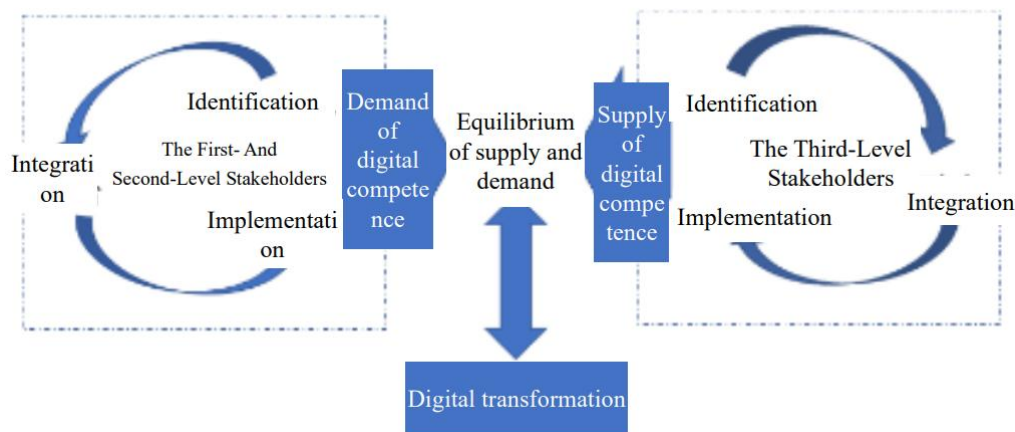
Figure 1 Supply-demand model of talent's digital competence cultivation

Stakeholders at any level need to go through steps of identification, integration, and implementation. The first- and second-level stakeholders rely on abundant information and data resources and utilize various approaches, methods, and tools to monitor, analyze, and identify needs for specific industrial capabilities. They then participate in policy formulation and integrate the required capabilities into formal national competency frameworks and industry training standards or above. They take part in the implementation of talent's capabilities cultivation by establishing governance policies, making financial arrangements, and formulating structures. At the same time as the above steps are completed, the first and second-level stakeholders also present the demands for the industry- and performance-oriented standardized digital capabilities. The third-level stakeholders, namely higher vocational colleges, explore and identify the competence needs of the market, students, graduates, and other sources through research and surveys to ensure that effective and timely competence knowledge, evaluation, and feedback are included in the curriculum and flexibly involve and set up courses and training that integrate relevant competences for the staff and students in front-line teaching organizations. By completing the above steps of identification, integration, and implementation, higher vocational colleges supply talent with the digital competence required by the market and industry.

Based on its characteristics of interaction and sharing, digital transformation further promotes the cooperation and exchanges between the suppliers and demanders of digital competence and achieves an ideal balance in supply and demand between the two different types of stakeholders based on the foundation and principle of efficiency. Under the demand and empowerment of digital transformation and through the steps of identification, integration, and implementation, and based on the gap between supply and demand, the higher vocational colleges as suppliers can naturally form a cooperation strategy from the top to the bottom. From the first-level stakeholders, the second-level stakeholders, to the third-level stakeholders, and driven by top-down strategy, higher vocational colleges as the third-level stakeholders, cultivate and develop key capabilities according to their own advantages, foster strengths, and circumvent weaknesses. When avoiding redundancy in talent cultivation, higher vocational colleges should join forces for output to achieve a better balance between supply and demand.

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