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學校創新：以三創跨域學程結構嵌入技術型學校課程系統之偏鄉案例

摘要

臺灣東部地區由於地理經濟等因素影響，孕育出許多與都會地區不同之文化特色，而學生的學習態度、技能學習、以及學校重點資源挹注都與都會地區有所差異。當中「創新」是當代經濟的關鍵詞，管理學之父彼得杜拉克 Peter Drucker 甚至以「不創新，即滅亡」來說明其之於未來經濟時代的重要。要如何在文化背景與資源均與都會區有別之情形下，培養學生具備創新力與思考力，進而具備職場競爭力以面對未來時代，學生創意、創新、創業(以下簡稱三創)能力的培養成了東部地區學校的重點挑戰。

為培養學生創新與思考力，進而具備職場競爭力，筆者參考 2015 年經濟合作暨發展組織(簡稱 OECD)所提之系統創新，於臺灣東部地區專科學校有限的師資、課程與資源之組織系統中，提出嵌入融合式設計的三創跨領域學分學程於課程系統內，將原本個別學科導向的課程系統，以結構性的課程變更方式，根本性的改變學校氛圍，形塑創新，預期能達到(1)培養學生提升基礎三創能力，擴展各科學生所學專業；(2)新創作品跨域開發，使學生具備較高之職場競爭力；(3)促進建立產學機制，使學校專業學習與社區有效接軌之目的。除採跨領域、多元教學、知識性、應用性與趣味性的教學方式，並規劃相關活動競賽，鼓勵並積極輔導學生爭取校內外榮譽，從中提升學生就業競爭力。此外，該學程的學生基於創新創業產生之目的，跨科修課自由度相對大，因而有助跨域學習。

而同 F. Geels 與 R. Raven(2006)的系統創新擴散的過程觀點，本文章透過辦理三創學程前後在學生新創作品獲獎情形，促進教師學術交流與產學合作之發展，與教師教學創新與環境活絡情形三個面向改變情形的討論，看出運用此組織創新方法設立三創學程後，除達成學程設立目的外，更超乎所求的使學生有更多參與國際競賽或專業研究機會，學校與社區的產學不僅能有效銜接，亦逐步產生創育模式，校際交流開始頻繁並締結策略聯盟。此外，校園學習氛圍亦越發活絡，不僅形成學校特色且可影響至社區。可說明本創新策略，除可促使學校組織內部有效形成創新，亦能影響地方產業經濟。

關鍵詞：組織創新、三創、融合式課程、跨領域、產學合作

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School Innovation: A Case of Embedding a Cross-Disciplinary CIE Program Structure into the Curriculum System of a Rural Technical School

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Abstract

Due to the influence of geographical and economic factors in eastern Taiwan, many cultural characteristics differ from those in metropolitan areas. As a result, students' learning attitudes, their ability to acquire skills and key resources at schools there are different from those in metropolitan areas. Innovation is the key word of the contemporary economy. Peter Drucker, the father of management, even used the phrase "innovate or die" to explain its importance in the future economic era. The authors are seeking how to train students to have the ability to innovate and think creatively despite their cultural backgrounds and resources differing from those in metropolitan areas, in turn obtaining the competitiveness needed for the workplace. The cultivation of students' capacities for creativity (C), innovation (I) and entrepreneurship (E) (collectively referred to as “CIE”) has become a key challenge for schools in this region.

In order to cultivate students' creativity, thinking skills and workplace competitiveness, the authors have referred to the system of innovation proposed by the Organization for Economic Co-operation and Development (OECD) in 2015. There are limited faculty, courses and resources at technical schools in eastern Taiwan. In this organizational system, is the authors proposed embedding innovative, cross-disciplinary CIE credits into the curriculum. The originally single-discipline-oriented curriculum system was changed structurally, foundationally changing the atmosphere of the school to promote innovation with the expected outcomes of 1) boosting the students’ foundational CIE skills and expanding the disciplinary scope of each student, 2) promoting the cross-disciplinary development of innovative products to allow students to boost their workplace competitiveness, and 3) promoting the establishment of an industry-academia cooperation system to effectively link learning to the community. In addition to adopting an instructional method that is cross-disciplinary, diversified, knowledge-based, application-based and fun, the curriculum also includes related activities/competitions and encourages and actively guides students to strive for honors inside and outside of school so as to enhance their workplace competitiveness.

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Furthermore, the purpose of promoting innovation and entrepreneurship in this curriculum includes considerable freedom in cross-disciplinary study and helps with cross-disciplinary learning. Moreover, through related activities, such as awards won by students' projects and the promotion of the development of teachers' academic exchanges and industry-academia cooperation, in the context of teaching innovation and the environment, we can indirectly see related organizational innovation methods that have driven the shaping of the school's unique characteristics. In addition, it is helping the development of local industries and forming a model of social responsibility for schools of higher education through inter-school exchanges and care for the local culture.

As with the concept of systematic innovation diffusion described by F. Geels and R. Raven (2006), this study discusses the changes in the state of awards won by students for projects, the promotion of academic exchanges among teachers and industry-academia cooperation, and the states of innovative instruction and environmental activation after implementing the CIE curriculum. The results show that using an organizationally innovative method in establishing the curriculum has not only allowed the program to become well-established but also has had the effect of inspiring more students than expected to enter projects in international competitions or obtain opportunities to participate in discipline-specific studies. The cooperation between the school and the community not only effectively created a more innovative education method but also led to more frequent exchanges and strategic alliances among schools. Furthermore, the learning atmosphere at the school was activated, in turn producing an effect on the community. Thus, the strategy boosted innovation within the school culture and even had an influence on the local industry and economy.

Keywords: Organizational innovation, CIE; fusion curriculum, cross-disciplinary, industry-academia cooperation

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1. Introduction

In Taiwan's education system, technical and vocational education were established due to the needs of technical professionals, especially in areas where the economy is to be developed. Agriculture, forestry, fishery, animal husbandry, industry and other industries are in the development process. Local residents pay more attention to the training of technical professionals. In eastern Taiwan, due to the rich diversity of ethnic groups and the natural landscape, the barriers of mountains and the distance have allowed economic development in major cities to nurture many distinctive customs. The differences in capacity to acquire skills and school resources are also due to factors such as geographical environment and economic development. The courses and school development focus of eastern schools are also different from those in metropolitan areas due to the above-mentioned factors. In addition, based on the basic economic needs of people's livelihood in rural areas, whether the local technical and vocational schools can cultivate appropriate talent, are good at using local natural and cultural resources, respect multiculturalism, create a community that is beautiful and good, and create a more stable economy for the local people's livelihood are all major issues. For technical and vocational schools in eastern Taiwan, these are intangible but relatively important subjects outside of school education.

In the contemporary economy, under the influence of various technologies and transnational cultures, all kinds of products are constantly being created and innovated, especially with the changes of the times. No matter how outstanding an enterprise is, it must continue to innovate to survive. The key to this is, as explained by Peter Drucker, the father of management, the concept to "innovate or die." However, for technical and vocational schools, various subjects usually have long-established syllabuses and courses that have used specific teaching materials and training models for many years but rarely lead students to think on their own or understand innovation, which is of course the case when they begin to work for an enterprise. This is especially true for areas in eastern Taiwan whose economic development is mainly characterized by agriculture. Besides the need for financial assistance in these areas, the authors also considered the possibility that "agricultural technology innovation is conducive to agricultural economic development and can better promote sustainable rural development" (Liu, Y. et al., 2021). For rural vocational and technical schools, whether it be cultural background, the acquisition of educational resources, or the various resources of the community, all are clearly different from those in metropolitan areas, and many cultural influences may even be added to the general syllabus. Under these circumstances, the authors have investigated how a school locates its value and proposes specific and effective practices in school affairs taking into account social expectations, such as the revival of the local culture, the prosperity of industry,

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and the cultivation of students' ability to think on their own and innovate in various workplace competitions. Faced with the old organizational system, schools obviously need to conduct systematic organizational innovation in order to effectively achieve the above goals regardless of environmental culture or talent cultivation expectations.

As the school's talent cultivation method used curriculum teaching as the main method and operates in a systematic manner, in order to cultivate students' thinking and innovation ability, and thus obtain workplace competitiveness, the authors decided to start with fundamental curriculum system innovation. Due to the career-oriented nature of technical colleges, the authors specially used the three stages of social and corporate innovation activities to put forward the idea of cultivating students' creativity, innovation and entrepreneurship (collectively referred to as "CIE"). Based on the limited number of teachers, courses and resources of a certain technical school in eastern Taiwan, which had adopted the traditional curriculum system, a cross-disciplinary CIE credit course has been added, and teachers have been encouraged to integrate the concept of CIE into their instruction. The addition of the CIE program was to help students be more adept at using creative ingenuity, innovating on the basis of their original technical capabilities, and even further their capacity for entrepreneurship. The establishment of this program used the system innovation described by OECD (2015), fusing it with the curriculum structure, which in turn promoted the formation of an innovative structure in the curriculum system and created a dynamic curriculum system change. Regardless of the organizational system changes that may have been affected, the hope for the CIE program in its early stage was to achieve the following objectives:

1.1 Boost the students' foundational CIE skills and expand the disciplinary scope of each student.

1.2 Promote the cross-disciplinary development of innovative products to allow students to boost their workplace competitiveness

1.3 Promote the establishment of an industry-academia cooperation system to effectively link learning to the community.

The operation of related programs was based on changes in user preferences, regulations, facilities and culture each year. This study will not only share how limited resources were used to set up the CIE program in junior colleges in eastern Taiwan but also discuss the CIE program setup strategy, the design of CIE courses and the impact of implementation on school organization.

2. Literature Review

In 1998, UNESCO presented the World Declaration on Higher Education for the Twenty-first Century: Vision and Action in Paris. Article 7 of the declaration states the need to strengthen

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cooperation with the world of work and respond to social needs, and Subparagraph (d) discusses the use of higher education in cultivating job-hunting capacity, creating employability and raising the capacity of higher-education graduates to cultivate their workplace ability. The system emphasizes that if the reform of the curriculum system is to respond to the requirements of Article 7, the establishment of creativity, innovation and entrepreneurship programs is indeed one of the best ways (including for technical colleges).

2.1 Organizational and technological innovation

The contemporary concept of innovation is mostly based on the innovation economy described by economist Joseph Alois Schumpeter. He believed that innovation is a "process of industrial mutation, that incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one" (Śledzik, K., 2013). In business and economics, innovation can be a catalyst for growth. According to Drucker (2002), innovation originates from possible emergencies, unexpected occurrences and incompatibility. Coordinating factors, such as incongruities, process needs, industry changes, market changes, demographic changes, changes in perception and the output of new knowledge, cause people to leapfrog the imagination to make the correct response. This imagination is a kind of functional inspiration and a driving force for innovation.

From the perspective of innovation capability, H. Tsai and S. Huang (2016) summarize the views of many scholars and roughly divide corporate innovation activities into (1) technology-based innovation activities and (2) non-technology-based innovation activities that emphasize organizational innovation. The key is to obtain an understanding that technological innovation ability has an intermediary effect on organizational innovation and performance. In addition to knowing that economic changes may affect organizations, they must also follow technological innovations. Technological innovations can also promote drastic changes in the world. OECD (2015) cited experts and scholars in the field of techno-economic analysis. Studies and theories on general-purpose technologies (GTP) and large technical systems (LTS) clarify the long-term relationship between technological innovation and the economy. However, a new and successful enterprise needs cooperation between its organizational innovation and technological innovation. The implementation of organizational innovation requires the support of technological innovation, and the implementation of technological innovation needs organizational innovation as a guarantee (Tsai, H. & Huang, S., 2016). Therefore, with the inspiration of innovation, besides guiding organizational innovation, the cooperation between industry and schools of higher education is often related to the research and

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development of technological innovation. For example, we may look at agricultural innovation in industry-academia cooperation. Agricultural industrialists need the support of research for the sake of innovation in agricultural technology, and they also have financing and marketing needs. Meanwhile, schools and governments can conduct the necessary research, and the creation of innovation platforms is viewed as "a promising vehicle to foster a paradigm shift in agricultural research for development" (Schut, M. et al., 2016), especially since the transition of agriculture "from technology-oriented to system-oriented approaches requires structural changes" (Schut, M. et al., 2016). These platforms should be managed by a public agency or non-profit organization to ensure impartiality. Besides the contribution research generally makes, the agricultural research conducted has the function of promoting innovative momentum on a number of levels (Lamers, D. et al., 2017).

2.2 System innovation

System innovation is actually a conceptual framework. It is defined as the fundamental innovation of a social technology system that fulfills social functions (OECD, 2015). System innovations are thus defined as radical insofar as they alter existing system dynamics innovations in socio-technical systems (OECD, 2015) and can be regarded as an excessive and fundamental solution for changes in management systems, which usually occur due to impacts or challenges in the broad-field environment (such as the climate, economy or population) or are generated within the system. For example, when the population within the system changes suddenly, the system must be used in another new form to deal with such impact, such as through the use of new skills, new infrastructure, new intermediary organizations or new rules/governance methods. For enterprises, internal system innovation requires architectural innovation (OECD, 2015), which does away with the existing technology-side or customer-side interaction methods, so it usually requires the generation of new business models, new regulations, new facilities and new cultures. System innovation and changes are usually a complex and long process. The transition period is roughly divided into four stages: development, take-off, breakthrough and stability. Since fundamental system innovation has a systemic impact on user preferences, regulations, facilities, culture, etc., in the open process of innovation, it is best to explore gradually expanding from the perspective of experimentation and learning. Of course, there may be risks or failures during experimentation and learning. The OECD (2015) specifically cited the system innovation diffusion process proposed in 2006 by Geels and Raven (Figure 1) to show that innovation is not only a result but also a continuous process of change.

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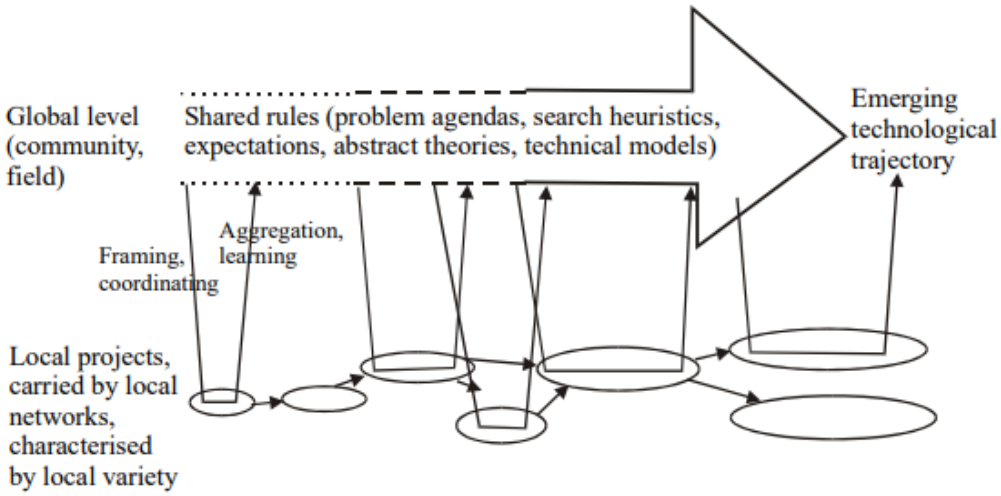

Figure 1. Diffusion as a process of niche-accumulation (Geels, F. & Raven, R., 2006, as cited in OECD, 2015)

Schools are inherently organizations with special functions. When an organization is carrying out foundational innovation, it is the same as the way J. Bessant et al. (2014) view radical innovation as a framing problem, that is, attempting to change the original routine within framing. This method happens to coincide with the OECD (2015) concept that "system innovation entails architectural innovation." To establish a successful foundation of innovation at a school, choosing appropriate functional systems inside and outside of the school to conduct architectural innovation is a good way to improve the foundation. Once it was decided that innovation would be conducted through changes to the curriculum system, embedding the CIE curriculum became a necessary aspect of the architectural innovation that spurred the success of innovation at this school.

2.3 General and entrepreneurial integration courses

R. W. Tyler (1949) divides the general curriculum into the four parts of the specific subject, broad field, core curriculum and experience curriculum to form the basis for the classification of curriculum forms. Subsequent curriculum classification has expanded on Tyler's. For example, the curriculum format of B. Lin and Z. Li (1970) includes subject-based courses, related courses, integrated courses, broad-field courses, core courses and experience courses. There are also scholars, such as Z. Huang (1991), who combine related categories. Regarding the integration of subject-based courses, related courses, integrated courses and broad-field courses as subject courses, the curriculum is divided into three parts: subject courses, core courses and experience courses (activity courses), the majority being subject courses. The curriculum system of higher education in Taiwan is also classified from this perspective. Subject courses are mainly established by various departments, core courses

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are based on general education centers and assistance for experience courses may come from academic affairs or internship units. This curriculum system forms a single vertical connection among the teacher, course and student.

Based on the nature of CIE, the establishment of the CIE program must be based on specific disciplines and possess talents that can engage in cross-disciplinary dialogue. However, for rural areas and some schools with small staffs, there exists the question of how to timely and effectively apply diversified and innovative teaching with knowledge, applicability and fun, as well as to encourage the integration of courses and essential concepts/practices of the CIE innovations into specific disciplines. In particular, entrepreneurship is mainly embodied in the realm of industry. Therefore, teaching in colleges and universities needs to focus on the integration of specific disciplines and innovation/entrepreneurship education (Chen, L., 2019). In addition to similar integrated teaching at American schools of higher education, the integration of entrepreneurship education and specific-discipline education in higher education, Z. Huang and Z. Wang (2013) specifically analyzed the three fusion modes of entrepreneurship education and specific-discipline education in the United States: the magnet model, radiation model and hybrid model. The magnet model refers to the concentration of entrepreneurial education in a few departments or the type of courses in the college. The radiation model disperses entrepreneurial education in individual departments or colleges and then manages it through the administrative department or center. The hybrid model combines the magnet model and the radiation model. In addition, some schools adopt staged and layered teaching in entrepreneurship education. However, the above are only distinctions among implementation modes. Other key elements that affect integration include financial support, infrastructure, professional teaching staff, teaching concepts/methods, curriculum development/implementation, entrepreneurial practice and alumni support (Huang, Z. & Wang, Z., 2013).

3. Setup and structure of the CIE program

The number of teachers at the technical school in eastern Taiwan that is the subject of this study is about 60 to 70, and there are six departments for the two-year and five-year programs. Before the establishment of the CIE course, the traditional teaching mode was adopted. Below is an analysis of that mode (Table 1).

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Table 1.
SWOT analysis of pre-CIE program school and region

Internal Analysis	
Strengths (S)	**Weaknesses (W)**
1. It is a technical college (which began as an agricutlural school) with many practical vocational courses, and all courses could be closely connected with local industries. 2. The faculty had deep practical experience in industries, and the promotion of industry-academia, technology transfer and training had achieved results. 3. Alumni have developed well in many places, and the industry has a high degree of connection and recognition, which is in line with the birthplace of new ventures. 4. There were various skill-verification venues, and teachers had skill-verification licenses and counseling experience, thus being able to help students obtain licenses.	1. Due to the remoteness of the school and the prominence of agriculture in the region, further education for teachers was restricted, and there was a weak connection between teachers and available resources, thus affecting teaching themes. 2. There were only six departments at the school. Most teachers taught in multiple disciplines and concurrently served as administrators. They were thus basically incapable of offering additional courses or inquiring beyond their specialties. 3. The students came from various cultures, and their technical competence and confidence needed to be enhanced.
External Analysis	
Opportunities (O）	**Threats (T）**
1. In line with the county government's policies, tourism and local industries are in urgent need of transformation and upgrading. The government interacts well with local industries, which is beneficial for arranging cooperative endeavors. 2. Many areas are natively inhabited by indigenous people, which will help the development of multicultural industries. 3. Local small and medium-sized enterprises develop talent needs, and the cultivation goals of various disciplines meet the needs of local industries and mid-level technical manpower. 4. Regarding local technical talent industry needs, vocational training is in line with filling the local manpower shortage.	1. Being remote, transportation obstacles affect industry development willingness. 2. The scale of industrial and commercial industries in the region is small and less-developed than in western Taiwan. Also, cooperating businesses tend to be relatively traditional industries. 3. Local multicultural communication and establishment methods are different and thus require effective communication. 4. The business industry is not booming, and it is not easy to get sponsorship or support funds from enterprises here compared with metropolitan areas.

The CIE program was the solution proposed by the authors based on the above relationships of strengths-threats (ST), weaknesses-opportunities (WO), weaknesses-threats (WT) and strengths-opportunities (SO). After the implementation and enhancement of the phased experience learning cycle, the weaknesses (W) and threats (T) gradually grew toward becoming strengths (S) and opportunities (O). After the CIE program was incorporated into the original curriculum system in a mixed mode, the school curriculum dynamics changed (see Figure 2). In addition, the establishment of the academic program used the perspective of learning in a more timely manner to incorporate the expansion process of the innovation system (see Figure 1), thereby completing the establishment of the learning core of the school organization in innovation and entrepreneurship. The innovative

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products produced by students in the program have provided students with the opportunity for entrepreneurship and off-campus technology transfer projects through the Research and Development Office and incubation center. Moreover, it can be seen from the above literature review that the establishment of the CIE program not only aims to produce technological innovation results but also uses the organizational innovation of the curriculum system innovation through the mutual supplementation of technology-based and non-technology-based innovations. This in turn has allowed for greater overall innovation at the school.

In order to use the resources at the school more flexibly, the authors adopted a mixed mode of integration. That is, each subject offers specific-discipline courses that comply with the concept of the CIE courses. Concepts can be taught in stages. The General Education Center is responsible for the development of core CIE courses, and assistance for the experience courses comes from the academic affairs office and internship tutoring units. As for the students, in addition to the necessary core courses, as long as regulations are complied with, they can take courses in other disciplines based on their personal interests.

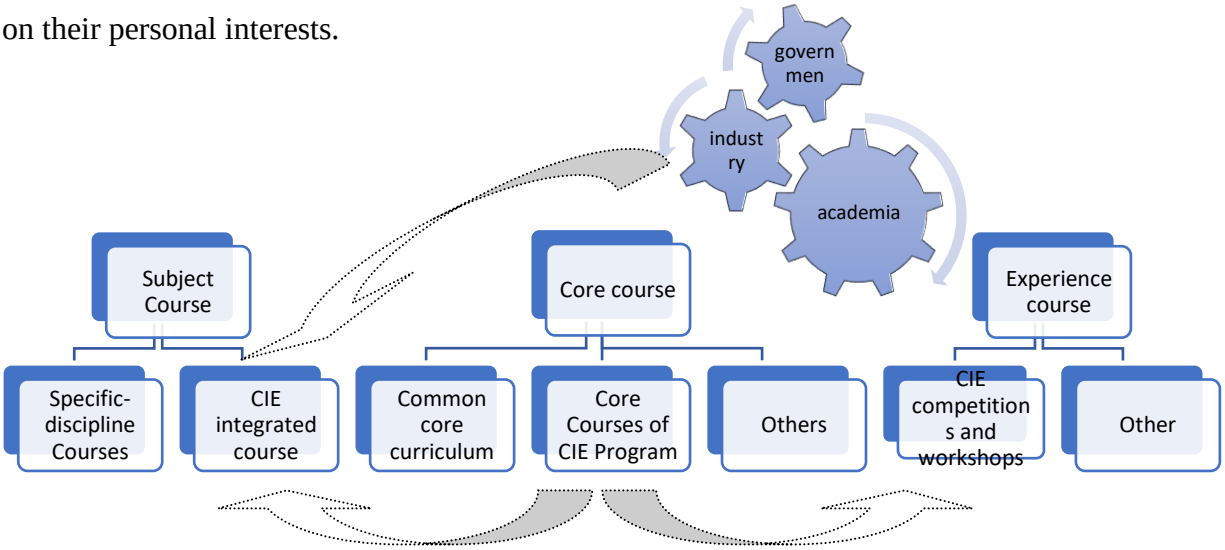

Figure 2. Structural relationship between school curriculum and CIE program

Since the curriculum system structure sees the addition of many horizontal links once the CIE program is in place (see Figure 2), it also indirectly promotes cross-disciplinary dialogue among the various subjects at the school. In order to provide CIE education more appropriately, we have also formed CIE support for the six dimensions of teachers, courses, grants, resources, localities and enterprises. We also cultivated and trained seed teachers, created CIE characteristic courses, established reward/subsidy measures, held CIE research activities, enriched CIE education resources and promoted CIE competition activities. We further enabled the school to face the impact of the (WT) with greater stability, as shown in Figure 2. The triple helix structure of university-industry-government relations (Etzkowitz, H. & Leydesdorff, L., 1995) is a collaboration between schools of

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higher education through cooperation with external government departments and the industry. It is not only a response to UNESCO's (1998) questions about strengthening and the world of work. The project operation, which cooperates with and responds to social needs through cooperation outside the school, also promotes the school's organizational innovation and technological innovation. When the school in this study established the CIE curriculum in 2015, the authors considered developing (SO) and allowing (W) and (T) to gradually transform into (S) and (O) (see Table 1). In the aspect of the short-term development strategy of industry-academia cooperation, the authors held to the school's agricultural foundation, developing in the area of agricultural-related industry with a focus on the feature of native crops. We also promoted agrotourism and conducted related packaging design to help develop the local features and boost the local economy. In addition to adding related thematic design to the CIE curriculum to create more creative agriculture products, we also look to guide related industry R&D and technology innovation.

4. Examples of integrated "Creative Thinking and Practice (CTP)" courses

As seen in Table 2, in addition to offering courses that integrate the concept of CIE into undergraduate majors in each subject, the core subjects also adopt a curriculum design model that integrates various disciplines. This was launched within the "Creative Thinking and Practice (CTP)" in the General Studies Center. As a case to illustrate, this course is mainly taught to students in the CIE program. Fourth- and fifth-year students in the five-year program and two-year program students from different disciplines learn together in mixed classes. Students from different disciplines, such as from the engineering, agriculture and management departments, are encouraged to work together in groups. Student-centered learning in which students must solve problems is adopted to stimulate thinking and creativity in different fields.

The CTP course content covers the important concepts of creative thinking, creativity training, patent and intellectual property management, innovative product development and commercialization. Through multiple teaching methods, such as lectures, demonstration, hands-on instruction and group competitions, students are taught to understand and learn by discovering problems, finding solutions, generating creative ideas and designing new product development procedures while learning about intellectual property rights protection concepts and knowledge systems. In order to establish a holistic concept of innovative product development, based on the academia-industry-government cooperation concept and the students' interests and areas of expertise, we planned out creative hands-on product-making activities. For example, during the 2019 academic year, the "Aromatic Essential Oil Mousse Creation" and "Dragon Boat Festival Wormwood Creative

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Product Packaging Experience" creative handiwork events were held, which the students collectively were highly satisfied with. The average score on the satisfaction surveys completed by the students (on a scale of 1 to 5 points) was 4.7 or more in the areas of planning, event administration and service. The relevant course unit modules are shown in Figure 3:

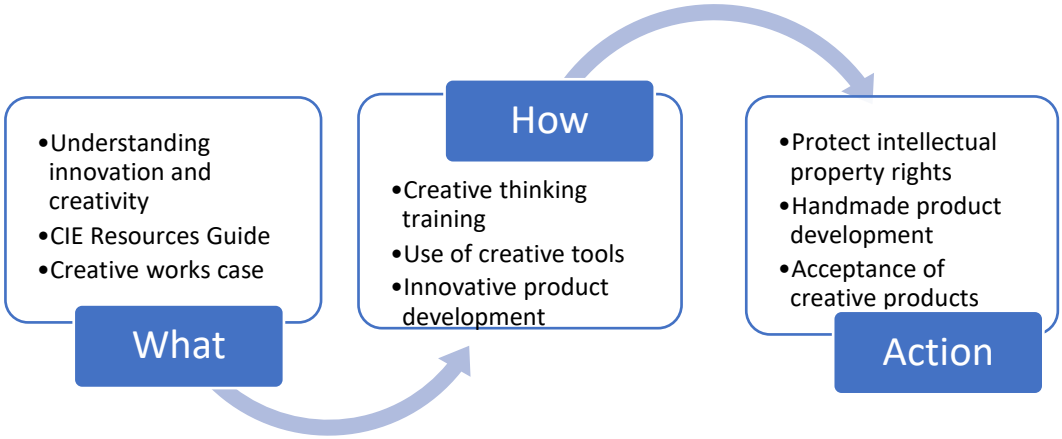

Figure 3. Creative thinking and practice course unit module

Due to the needs of the curriculum, the teachers of the CIE core curriculum focus on the introduction of practical new product cases and then guide the students to discuss the economic value of commodities and develop integrated or related products. The students adopt a fusion grouping approach, so there are plenty of opportunities for discussion. They can stimulate creativity through discussions with each other and learn to understand the ideas and thinking methods of others through effective listening, communication, dialogue and reflective feedback. This allows them to support and cooperate with each other and make new creations of their own. Such method can be said to be a literacy-oriented method established through expression and practical operation. Therefore, students who take this course can gain an understanding of not only the significance of CIE education but also the diversity in product development and the skills required for product development. There are many opportunities to create new products through the training from the course. The students boost their problem-solving and thinking-learning abilities, expand their undergraduate skills and further cross-disciplinary learning and connection.

Students are encouraged to submit the excellent works they have produced during the course to relevant competitions at home and abroad. For example, in 2015 a Solar Water-condensation Device was made. After fusion and organization, it was created through cross-disciplinary discussions that stimulated creativity. The device uses solar energy to condense moisture in the air to make water. It uses a combination of solar power cells and a heat exchanger. The moisture in the air is condensed and collected in a water storage tank for use as an emergency or auxiliary water supply source during a disaster or water shortage. The power required by the fan, refrigeration chip module and submersible

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motor in the heat exchanger is supplied by the solar cells. The refrigeration chip is attached to the heat exchanger. The air is brought by the fan through the filter, enters the heat exchanger and is then cooled by the refrigeration chip so that the temperature of the moisture in the air drops below the dew point and condenses into droplets. The water collects in the storage tank for later use. The system design is shown in Figure 4.

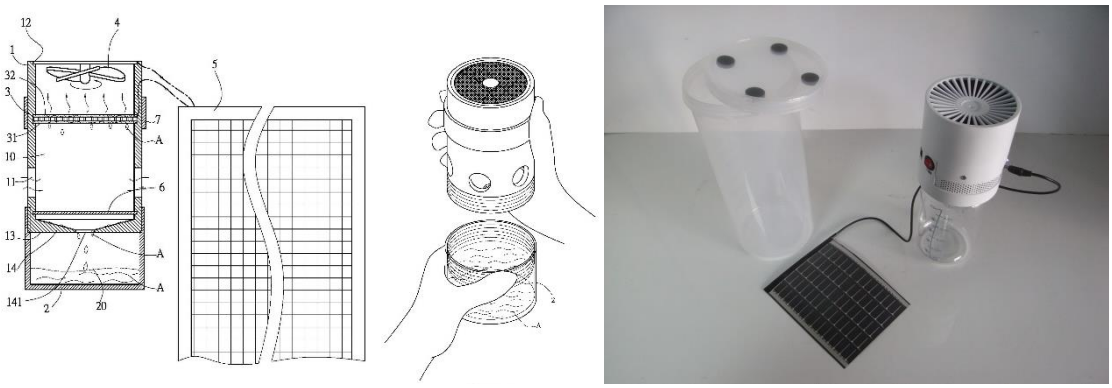

Figure 4. Solar Water-condensation Device

、This product is an effective tool for irrigation in places that lack water, which is obviously helpful in agriculture. A patent application was submitted for this product. It can be used as a foundation for students to take a further step toward starting a business via a patented product. It can also provide relevant technology transfer for commercial use in the industry and academia. This project was the first entry from the school at the ITEX International Invention Exhibition in Malaysia (in 2015). It won a gold medal, and another product made by students and teachers at the school, an Ultrasonic Cleaning Apparatus, also won a gold medal at that same competition.

The students filled out CTP course surveys (responding to questions on a scale of 1 to 5), 28 of which were valid and analyzed to produce the results in Table 2. According to the results, the students' level of cognition for each instructional unit was between 2.75 and 3.54 before the course, and it increased to 4.14 to 4.54 afterward, showing that their cognition of innovation, creativity and creativity-related curriculum units improved significantly.

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Table 2.
Scores on degree of cognition for each unit of instruction

Unit	Before instruction	After instruction
Cognition of innovation and creativity	2.93±0.77	4.29±0.53
Creative thinking training	2.54±1.29	4.50±0.51
Guided reading and use of books from the CIE curriculum	2.64±0.99	4.14±0.80
Concepts on innovation and product development	2.82±1.06	4.36±0.56
Creative product examples and hands-on experience	3.04±0.96	4.36±0.56
Product development and intellectual property rights protection concepts	2.75±1.00	4.39±0.57
Product design competitions and evaluation process	3.04±0.92	4.18±0.77
Use of online instruction platform and uploading results	3.54±0.88	4.54±0.64

5. Discussion and conclusion

Since the launch of the CIE program in 2015, the school has allowed students to boost their CIE skills and expand their disciplinary scope. Below, based on the awards students have won for their creations, we discuss how the CIE curriculum has achieved the cross-disciplinary development of innovative products to allow students to boost their workplace competitiveness. Then, based on the promotion of the teachers' academic exchanges and industry-academia cooperation development, we discuss how the curriculum promoted the establishment of an industry-academia cooperation system to effectively link learning to the community. Finally, we discuss how the instructional innovation and activation of the school environment after the establishment of the curriculum positively influenced the school organization culture.

5.1 Awards

Since the implementation of the CIE program, teachers and students worked together to develop new products, such as the Solar Water-condensation Device mentioned above. They participated in the Malaysia ITEX International Invention Exhibition for the first time in 2015, winning two gold medals. According to statistics from 2015 to 2017, during the early stages of the CIE program, more than 30 students from the school entered projects at the international competitions of the iENA in Nuremberg, Germany, the Taipei International Invention Show & Technomart and the ITEX in Malaysia, winning more than 10 gold, silver and bronze medals. The school's students gained unparalleled confidence and a sense of accomplishment from this. Domestic competitions they have entered outstanding works in include the 6th TBSA National College Innovation Planning

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Competition in 2016, the Local Potential Industry Entrepreneurship and Brand Marketing Competition, the Craft x Design IN Taitung "Bonfire and Starry Sky" Cultural and Creative Design Competition, the 2015 Kolin "Discover and Enjoy the Beauty of Taiwan with Heart" Competition, the 2015 Environmental Issue Art Creation Competition, the 2015 Taitung Art Exhibition and the 2015 National LED Creative Design Competition. As for entrepreneurial competitions, the school won five awards from the 2015-2016 "Dream Power" Student Entrepreneurship event. In addition, with the promotion of the school's CIE program and teachers' active guidance, students were awarded for the 2014 Solar Emergency Auxiliary Water Supply System and the 2017 Design of New Water-absorbing Ceramic Flower Products, which were developed under the auspices of the Ministry of Science and Technology College Student Research Project. In addition, teachers and students co-created the patented Ultrasonic Vibration Water Purifier and also received a grant from the Ministry of Science and Technology to encourage the carrying out of a practical research project in 2020. It can thus be seen that, in addition to specific new achievements after the establishment of the CIE program, more students have been able to win awards or obtain specific-discipline research opportunities through their works. The curriculum allowed students the experience of developing patented products and winning awards, which will help them in their future careers to develop and market products, and they may even use the products they have developed to start their own businesses.

5.2 Promotion of the development of teachers' academic exchanges and industry-academia cooperation

Due to geographical location and transportation, the commercial and regional development in eastern Taiwan has fallen behind that of the west. Rural technical schools hope that through social innovation action, that is, through the innovative application of technology and business models, all groups in society can be changed. Through such changes, they hope to find innovative ways to solve social problems (Executive Yuan, 2018a) and gradually reach the United Nations' 17 SDGs (such as eliminating poverty, gender equality, responsible production and consumption, elimination of inequality and high-quality education) and related visions of the sustainable development of indigenous culture (Executive Yuan, 2018b) in order to deal with the WT in Table 1. In terms of implementation, schools can promote community and regional school resource links, cultivate talent in the community or at school with innovative thinking and practice or promote social innovation cultivation and experimental fields with local entity platforms (Executive Yuan, 2018a). Looking at the establishment of the CIE program from this perspective, it can be seen that the program not only allows many innovative and creative inventions to be made but also promotes considerable

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advancement in the development of industry and academia. It is also in line with the community industry and academia. From the establishment of strategic alliances, a creative and educational model has been gradually produced.

In 2015, teachers and students developed the Complex Orange Fermentation Liquid and Orange-based Environmental Cleaning Liquid through an industry-academia cooperation project in 2015. These products have been made available for sale at township farmers' associations. In addition, they were awarded trophies for "Assisting the Farmer's Association in the Development of Local Agricultural Specialty Products-Orange-based Enzyme Liquid and Environmentally Friendly Natural Cleansing Essence" on Farmer's Day by a township farmers' association. In 2016, they won the county farmers' association's "Sweet Orange Yeast Liquid Technology Transfer Authorization Contract Transfer Agreement" to continue to assist farmers in developing more economically valuable products, increase farmers' income, solve the problem of slow sales of special local agricultural products and boost the local economy. Also through the research and development of product sales, farmers' income was boosted. There are also cases in which the development of other special agricultural products in the region has promoted economic benefits. In 2017, teachers from the school were commissioned to develop innovative red quinoa products, and they came up with the Red Quinoa Healthy Drink. In 2018, they obtained a manufacturer's technology transfer contract for this product. The study cooperation program provides students with many opportunities to participate in off-campus internships. Students participate in design, production and post-processing, witness the development of various processes and become more familiar with local enterprises. From 2017 to 2019, teachers and students co-created three patented inventions and six utility-patent inventions. The effects and success of the CIE program since its establishment are thus apparent.

As a result, in 2017, the school was awarded a place in the University Social Responsibility Practice (USR) Program of the Ministry of Education-Industry Value Added and Local Practice Educational Experimental Program, using industry-practice two-dimensional learning combined with campus environmental innovation, teaching innovation, social participation of tribal villages and communities and regional integration of local teaching resources to build a learning circle with a ripple effect in the field from the inside out and from the small to the large. With the support of the plan, through the connection and reconstruction of technical and vocational education at technical schools and regional industries, the school worked with the community in innovating and recreating value in indigenous villages and communities and further promoted innovative business strategies and the development of special industries in the city. In the aspect of academia-industry-government cooperation, as the number of innovative inventions grows, dialogue and exchanges between the school and other academic organizations and between the school and the industry have increased.

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Besides more and more cooperation with the community, the school has also formulated a new agriculture development strategy alliance development plan based on the Global Research and Industry Alliance—New Agriculture Program (Shieu, F., 2019).

5.3 Instructional innovation and activation of the environment

Due to the establishment of the CIE program, the school has made many breakthroughs in supporting the CIE approach, indirectly promoting teachers' exchanges and interactions via production, education and teaching innovation. Teachers have gained many more opportunities to be involved in more interactive activities based on common goals. In terms of teaching, CIE teachers need to strengthen social connections, and there is a high demand for professional teachers. When the school interacts frequently with the outside world, relevant teachers especially need the joint support of teachers with considerable expertise from all walks of life, government and academia. At present, besides part-time teachers in the field, most of the collaborative teaching methods involve introducing course resource support from local sources. In order to improve teaching quality, the school also organizes training seed teachers to encourage teachers to look beyond traditional concepts and try to innovate, such as through flipped teaching methods, different forms of integration of the curriculum structure, the design of multiple core competence courses, etc. It has also established a cross-discipline innovation reward mechanism and developed cross-discipline courses. At present, various fields have proposals for teaching innovation. For example, life science courses plan to include such classes as "The Taste of Life," "Life Character," and "Ecological (Environmental) Quality." English instruction is based on a focus on the local culture and taking action, and informal curriculum activities, such as "Daily English, Talks from the Masters & Green Creativity" are organized. In addition, the technology of the multi-functional classroom is used to its full extent to develop digital teaching materials and innovative teaching methods.

Furthermore, since teachers are eager to hone their abilities with the gradual increase in the momentum of the CIE, and due to the joint preparation of lessons and the mutual observation learning model of teacher community activities, an inter-school teacher community has gradually developed over the years, allowing them to discuss industry-academia cooperation, academic research exchanges and innovative teaching. This has provided more opportunities for the school to communicate with the academic and teacher communities at other schools, thereby enhancing R&D capacity and expanding educational influence by such means as participating in regional teaching resource centers, sharing research/teaching resources and exchanges with/visits to other schools. This has gradually turned into part of the normal operation of the teacher community. The school also

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encourages teachers to study, participate in academic seminars and publish research papers to promote research and development so that more achievements can be made and promoted.

In addition, the school's learning atmosphere can be seen in detail due to the appropriate improvement of learning goals and environmental equipment. By developing the CIE program, related books and digital learning resources have increased, and there is now a CIE learning and display area. Faced with the needs of innovative technology, teachers of various subjects are more actively seeking funding to update teaching and research equipment, and research momentum is gradually making breakthroughs. In addition, the learning atmosphere also is now different due to the school's promotion of CIE competitions. The power of students' creativity and ability to think on their own is now integrated holistically with life goals and vitality through the cohesion provided by activities. For example, each unit of the school is based on creative thinking. With many dynamic and static display activities of artistic and cultural creativity, the school's learning atmosphere has been activated, in turn promoting the school's innovative characteristics, which has even extended to the community.

6. **Discussion and conclusion**

This study discusses how a school in rural eastern Taiwan has used education to aid in the process of changing the local industry. By means of embedding a cross-disciplinary, credited CIE program into the school curriculum, the school has successfully guided students in learning about innovation, creativity, and entrepreneurship, achieving the three goals of 1) boosting the students' foundational CIE skills and expanding the disciplinary scope of each student, 2) promoting the cross-disciplinary development of innovative products to allow students to boost their workplace competitiveness, and 3) promoting the establishment of an industry-academia cooperation system to effectively link learning to the community. In addition, due to the use of a method that has an innovative foundational organizational structure, the strategy effectively activated the atmosphere at the school to make it more innovation-oriented, bringing about development in the area of the school's unique characteristics and creating a positive influence on the community's industry and culture. This innovative method allowed the school to achieve organizational innovation, serving as a good example of a school that exhibits care for the community and aids in local industrial development. It is also a great example of organizational reform in guidance-based education.

As described by the process of system innovation diffusion of Geels and Raven (2006), system innovation can be regarded as a process of niche accumulation. Through the strategy of situation analysis and the method of organizational innovation, a junior college in rural Taiwan embedded a

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CIE program into its courses, not only establishing a CIE curriculum but also allowing for more possibilities in the curriculum dynamic. As stated above, students have not only enhanced their knowledge of innovation, creativity and entrepreneurship but also had their confidence and employment competitiveness boosted through competitions inside and outside the school. Also, the curriculum has allowed them more opportunities to join international competitions, themed projects and research programs for college students. The system innovation has driven organizational innovation. It provides positive feedback for students' learning and promotes the development of teachers' academic exchanges and industry-academia cooperation. For example, industry-academia cooperation with companies in the community has specifically yielded the development of such products as the Complex Orange Fermentation Liquid, the Orange-based Environmental Cleaning Liquid, and the Red Quinoa Healthy Drink, pushing innovation vitality between industry and academia and helping the local economy through technological innovation and creative products. Because of this industry-academia development, exchanges between the school and other academic organizations and companies have become more frequent. Also, the school has formulated a strategy alliance development plan. Furthermore, the creative thinking of the CIE program has pushed teaching innovation and the activation of the campus environment. Aside from using more innovation in their instruction, teachers are making more outstanding achievements in the area of R&D in related industrial technology.

For education, not only does industry need innovation, but school organization does too, especially because growing and learning is a process of continual innovation, and the global learning model is gradually trending towards sustained learning. Innovation in organization, systems and teaching has also become constant, allowing for adaptation to changes and the pursuit of breakthroughs. Growing and learning are not only needed at technical schools; they are required for advancement by people around the world. Any school organization may use innovation in its system, organization or technology to produce more innovative energy in the face of this global variable of learning. The school which is the subject of this study using an embedded CIE program in its curriculum to carry out organizational innovation is a stage in the process of innovation for the system. In the future, programs for the intermediate and advanced stages will be developed. We may not know how the environment will change or how to deal with changes in the economy and life of the future, but this method of learning has allowed us to more firmly believe that anything is possible with the power of innovation and creativity that drives human growth. In this way, we will have the power to face difficulties and forge ahead.

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