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Reengineering Industry-Oriented Educational Programs at Senior High Schools in Taiwan

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ABSTRACT
The objective of this study was to assess attempts to bridge the gap between study and application in industry-oriented technology programs at senior high schools in Taiwan. This education reengineering project was implemented in an attempt to provide students with more immediate employability upon graduation. Teachers of professional subjects in senior high schools in Taiwan were the participants in this study. A total of 945 questionnaires were distributed using purposive sampling, of which 742 valid questionnaires were returned, a recovery rate of 78.50%. This study includes a literature review, discussions with experts, and a questionnaire. Following questionnaire development and distribution, results were analyzed using SPSS. Respondents that had taught for 21 years or more expressed greater approval of the project than those that had taught for 5 years or less. On the whole, teachers at senior high schools show a high level of approval for project implementation.

Keywords: technology education, senior high school, industry-oriented

INTRODUCTION

Technology education has played an important role in economic growth and industrial development in Taiwan. Taiwan's technology courses focus on pragmatism and practicality, enabling students to acquire expertise by doing, which equips them to enter their target industries immediately following graduation. Taiwan's technology education has produced a wealth of talent that has proven crucial to Taiwan's economic development. Chien (2017), for example, developed an integrated-STEM CO_2 dragster design course using 3D printing technology for high school technology education. Students took a pre-engineering curriculum, then were assessed for differences in creativity, race forecast accuracy, and learning performance.

The Council for Economic Planning and Development made a population projection report in August of 2008 for the period from 2008 to 2056. The report predicted a continuing decline in the school-age population. This will affect resource allocation for all levels of education and exert a profound influence on future human resources (Pan, 2016). Investing in human capital requires a flexible education system that focuses on the innovative abilities and employability of young people. This study is motivated by the need to improve senior high school technology education.

In recent years, globalization and the international political environment have accelerated change in the industrial structure and production patterns in Taiwan. Taiwan's overall industrial structure is focused on high technology. Researching the strategies used in the reengineering project is thus a second motive behind this study.

The Industrial Development Bureau of the Ministry of Economic Affairs established a webpage to provide information on standards and evaluative measures for industry competencies. These standards serve as reference for students, training institutions, individuals, and corporations. This study is motivated to find effective strategies for coping with a changing market environment.

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Contribution of this paper to the literature

- This study surveyed attempts to reengineer industry-oriented education in senior high schools in Taiwan.
- This study investigated institutional adjustments, course activation, and employment promotion in industry-demand-oriented schools in Taiwan.
- The contribution of this study lies in its analysis of empirical data gathered after project implementation. The results provide reference for relevant project reviews, corrections in execution, and future plans. Properly implementing technology education projects is a key to successfully cultivating technology talent in Taiwan.

RESEARCH AIMS

This study investigated institutional adjustment, course activation, and employment promotion in industry-demand-oriented schools by examining the second phase of attempts to reengineer these programs. The results of this study provide theoretical and practical reference for project assessment and administrative applications.

LITERATURE REVIEW

Skills are the mainstay of vocational schools that form the foundation of industry in Taiwan. The united nations educational, scientific, and cultural organization (UNESCO) defines technology education as "those aspects of the educational process involving, in addition to general education, the study of technologies and related sciences and the acquisition of practical skills, attitudes, understanding and knowledge relating to occupation in various sectors of economic life" (Hollander & Mar, 2009). Chao, Tzeng, and Po (2017) combined hand-weaving techniques as a preliminary course with project-based learning to explore and research the problem solving process of aboriginal senior high school students during e-book production.

Low Birth Rate

The Japanese government was the first to use the term "declining birth rate" in 1990. Aging societies form when senior citizens exceed 7% of the population. Declining birth rates mean the overall population will fall, impacting various aspects of society such as social structure and economic development (Nomura & Koizumi, 2016).

According to the Organization for Economic Cooperation and Development (OECD), population structure equilibrium requires that each woman must give birth to 2.1 or more children. This number is referred to as the population replacement rate. The 2 in 2.1 refers to the number of children needed to replace the mother and father, whereas the 0.1 serves to cancel out the newborn fatality rate (Biswas, 2016).

Due to declining birth rates, the student population in Taiwan has been declining annually. Insufficient enrollment is forcing many schools to merge with other schools, undergo transformation, or even shut down.

Industry-Oriented Education Programs

The population structure of Taiwan presents low birth rates, aging, and heterogeneity. Low birth rates have already exerted a profound impact on domestic industrial, social, and educational development. The unemployment rate increased from 3.71% in January of 2015 to 4.08% in 2016. Structural issues are causing the unemployment rate to continue to rise (Salop, 1979). Many college students do not have an adequate understanding of their majors before they choose them. Consequently, few students actually go into industries relevant to their major, creating a gap in professional talent. A lack of career planning or lack of work experience prompt students to go back to school or delay their graduation. Skill and educational mismatches result in inadequate employability, resulting in an industry-academia gap.

According to the national development council of Taiwan, the service industry accounted for 63.15% of the GDP in 2016 and 59.17% of the employed population. This shows that the service industry has become the main body of economic activity in Taiwan and is the main source of job creation. The information and communications technology (ICT) industry has become the center of global production. In 2015, Taiwan was a global leader in the wafer foundry industry and the IC packaging industry; the output value of the former occupied 73.70% of global output, while the latter accounted for 51.80% of global output. In 2016, the overall manufacturing industry produced 30.16% of the GDP, while industry accounted for 35.04% of the GDP (Chien & Chen, 2017), as shown in **Table 1**.

Table 1. Overall economic indexes of Taiwan from 2013 to 2016

Dimensions	Unit	2013	2014	2015	2016
Economic growth rate	%	2.20	3.92	0.75	1.50
GNI per capita	Current value (USD)	22,526	23,308	23,131	23,284
Consumer price inflation rate	%	0.79	1.20	-0.31	1.40
Employment growth rate	%	0.99	1.02	1.08	0.62
Unemployment rate	%	4.18	3.96	3.78	3.92
Government expenditure as percentage of nominal GDP	%	19.27	18.74	17.63	17.98
Private expenditure as percentage of nominal GDP	%	71.79	70.76	69.25	70.02
Agriculture as percentage of nominal GDP (production approach)	%	1.69	1.80	1.70	1.82
Industry as percentage of nominal GDP (production approach)	%	33.46	34.79	35.13	35.04
Manufacturing as percentage of nominal GDP (production approach)	%	28.75	29.99	30.05	30.16
Service industry as percentage of nominal GDP (production approach)	%	64.85	63.41	63.17	63.15
Export of goods and services	Current value (USD)	3,574	3,721	3,400	3,336
Import of goods and services	Current value (USD)	3,098	3,172	2,716	2,696
Trade surplus of goods and services	Current value (USD)	476	549	684	640
As percentage of nominal GDP	%	9.30	10.36	12.89	12.09
Savings rate	%	32.00	32.95	34.41	34.04
Investment rate	%	21.46	21.20	20.27	20.22

Social diversity and dramatic changes in the industrial environment have resulted in a more specialized division of labor. While professional skills are obviously important, they do not indicate competitiveness. Industries must plan in advance and cultivate international mobility and global competence in students. In the face of global transformation and development of the digital economy, in-service talent will not necessarily have enough professional knowledge or skills to meet the needs of market development. To enhance competitiveness and assist in talent transformation, on-the-job training and development courses should be offered based on industry trends. Ongoing adjustments can be made to the course contents so as to reinforce talent resources in the industry (Pick & Nishida, 2015).

Development of Senior High Schools in Taiwan

The aim of vocational education in Taiwan is to teach professional knowledge, cultivate professional ethics, foster capable technical personnel, develop basic occupational skills, promote work attitudes such as dedication, teamwork, trustworthiness, enterprise, and diligence, improve humanistic and technological literacy, enrich personal lives, promote innovative thinking and adaptive abilities, and cultivate interest in further studies so as to lay the foundation for career development.

The Ministry of Education's white paper on talent cultivation served as the blueprint for education in 2013 and 2014. It specified objectives for cultivating outstanding and dedicated teachers, bridging the gap between study and application, enhancing the global competitiveness of students, increasing the future productivity of students, and thereby achieving the cultivation of diverse and genuine talent and the creation of a happy and prosperous society.

In August of 2014, the Ministry of Education officially introduced twelve-year compulsory education, the Vocational School Law, which governs vocational high schools, and the Senior High School Act, which governs regular and comprehensive senior high schools, were combined to form the Senior High School Education Act. Vocational high schools were renamed senior high schools, and they are currently one of the foci of educational development. The Senior High School Education Act specifically states that senior high schools are one of the major types of schools and stipulates that they must establish programs and specializations in accordance with national development, society, industry, the attributes of the vocational discipline, and student careers (Ministry of Education, 2012).

After examining the vocational education and training of member states, the Organization for Economic Co-operation and Development (OECD) compiled the Skills Beyond School Synthesis Report to discuss the mechanisms of technical education institutions, present advantages and suggestions regarding each member state, and reveal that short-term higher education after secondary education is the main source of quality technical manpower in advanced countries (José-Luis, 2015; Winther-Jensen, 2015).

Article 9 in the Technology Education Act, which was promulgated and implemented in January of 2015, stimulates that "elementary schools, junior high schools and senior secondary schools shall provide vocational information and workplace-visit courses and career guidance courses, or incorporate vocational information, workplace visits, and career guidance into other courses to provide students with opportunities to learn about different vocational possibilities and establish a proper system of values pertaining to vocations and employment. The curriculum guidelines of elementary schools and junior high schools shall incorporate vocational knowledge and exploration content; senior secondary schools and junior high schools shall arrange visits to related businesses and industries for students" (Yu & Hu, 2017).

Coppola, Hiltz, and Rotter (2004) posited that students generally hope to learn from their teachers via direct instruction and interactive course content. This direct exchange must remain consistent throughout the course so that teachers and students can build and maintain a trusting relationship (Dorff, 2016).

Secondary education systems vary widely from country to country in terms of objectives, structure, resources and limitations, so it is difficult to compare the validity of these systems. The implementation of new teaching methods and teacher decisions are influenced by the expectations, beliefs and teaching styles of individual teachers (Vidic, 2017).

In the 1990s, e-learning was still in its preliminary stages. Most educators were skeptical of this new learning model. However, widespread technological development has made this mode of learning impossible to ignore. Teachers need to consider the learning effectiveness of their courses then design courses and learning activities that encourage student participation and interactions. E-learning has provided many new avenues for teachers to ensure that the educational experiences they offer are adequate in both quality and quantity (Mehta, Makani-Lim, Rajan, & Easter, 2017).

Schools thus began to plan professional courses that would bridge the gap between study and application. Teachers adjusted their teaching methods, striving to achieve academia-industry collaboration. Assessment methods now take different learning styles into account, promoting adaptive development in students and enhancing their employability in the hopes that they will obtain employment immediately following graduation.

Progress in big-data technology and technological innovation is rapidly altering the traditional structure of industry. Scope expansion and R&D are proceeding much faster in industry than in education. The lack of training and development of technical experts and vague talent cultivation mechanisms are affecting economic growth rates. These are currently core issues under discussion (Chen, 2010).

The virtual world (VW) is a virtual environment in which users can perform interactions using avatars. These avatars usually represent users as three-dimensional (3D) subjects that can freely interact within other avatars and world elements (subjects) in the virtual environment. A number of high-school students have found programming concepts more appealing when introduced via VR education platforms (Rico et al., 2011).

The Ministry of Education implemented the first phase of change in industry-oriented technology education between 2010 and 2012. The purpose of the project was to strengthen the development of pragmatic skills and fulfill the role of technical manpower cultivation. Ten strategies were formulated in the following five dimensions: system, teachers, courses and teaching, resources, and quality control. Preliminary success was achieved in the teaching environment, the strengthening of industry-academia connections, and the cultivation of quality professional talent (Grainger, Liz Bowen-Clewley, Maclean, & Matheson, 2016; Huang & Liao, 2016).

Changes in social ecology for educational development represent a two-way causal relationship (Cuadra & Moreno, 2005). A gap between study and application still exists in the demand from industry and the supply provided by educational institutions. Graduates often lack practical work experience, so skill and educational mismatches have long been a problem. In addition to providing new employees with pre-employment training, academia-industry collaboration should increase, and talent cultivation and industry practicum should be further promoted so students can prepare for future employment (Shyr, Liu, Liu, & Feng, 2017).

From 2013 to 2017, the Ministry of Education pooled resources from industry, government, and academia to formulate development strategies for technology education and implemented the second phase of change in industry-oriented technology education to cultivate the technical manpower needed for industrial development. The objective was to combine these resources, link them to the needs of industries and corporations, cultivate the technical manpower needed on various levels, and enhance the overall competitiveness of technology education (Wang, 2016).

The second phase of the project comprises three major constructs and nine strategies: institutional adjustment (project integration, discipline adjustment, and practical talent selection), course activation (flexible courses, equipment renewal, and practical skill upgrade), and employment promotion (employment convergence, innovative entrepreneurship, and combining certification with competency). The project funds were mainly aimed at renewing equipment for experiments in school subjects associated with manufacturing industries and key industries with technical labor shortage. The hope was for graduates to become immediately employable, provide the talent needed for industrial development, and enhance the overall competitiveness of technology education (Baumann & Winzar, 2016). The main points strategies are listed in **Table 2**.

Table 2. Reengineering industry-oriented technology education

Project		Execution strategy
Institutional adjustment	Project integration	(1) Gather competent authorities of industry, vocational training, and education for regular meetings to bridge the gap between study and application. (2) Set up a communication platform and develop mechanisms for talent cultivation and technical collaboration. (3) Make special laws for technology education.
	Discipline inventory	Assess the disciplines that schools offer and the total number of students they can enroll based on industry needs to balance the supply and demand of industrial talent.
	Practical talent selection	Increase the percentage of non-multiple-choice technical competency tests in college entrance exams.
Course activation	Flexible courses	Enhance flexible courses that converge with employment, workplace ethics, and practicum.
	Equipment renewal	Renew teaching equipment in three stages for convergence with industries with technical labor shortage.
	Practical skill upgrade	Arrange practicum for students on and off campus (domestically and abroad); recruit industry experts to assist in teaching and have teachers study at public and private institutions; reinforce practical teaching materials and teaching abilities.
Employment promotion	Employment convergence	(1) Offer industry-academia cultivation courses to help students prepare for employment. (2) Establish life and career progress files and convergence mechanisms to guide students in adaptive education, employment, and life development. (3) Formulate employment convergence, follow-up surveys, and counseling mechanisms for graduates.
	Innovative entrepreneurship	Promote a culture of innovative entrepreneurship on campus, assist local school research achievements to become innovative businesses and winning entries of international invention competitions in commercialization, and match local industries with the employment manpower that they need.
	Combining certification and competency	Enhance the employability of students.

METHODOLOGY

This study used literature review, questionnaire, and discussions with experts, adopting both qualitative and quantitative methods. The content structure of the formal questionnaire in this study comprised two parts. The first part collected demographic information, and the second part assessed strategies for reengineering industry-oriented technology education.

Research Process

We employed document analysis and a questionnaire. We collected, read, and analyzed government policy reports, official websites, literature, academic articles in foreign and domestic journals, magazines, video reports, and conference papers to construct a research framework and compile a questionnaire to serve as the research tool of our study.

Expert Meeting

Upon completion, the first draft of our questionnaire was reviewed by a group of twelve individuals, including industry experts, research experts in relevant fields, and the directors of practicum and internship programs at skills-based senior high schools. They examined the appropriateness of the wording in the questionnaire and provided suggestions for revision, thereby establishing the content validity of the research tool and providing crucial reference for the formal questionnaire.

Questionnaire Design

To fulfill the research objectives, the questionnaire was designed to collect data for professional competencies in 3 dimensions: (1) Institutional adjustment, (2) Course activation, (3) Employment promotion. A Likert scale was used to represent participant views, with 5-very important, 4-more important, 3-some-what important, 2-less important, and 1-least important rating factors related to their job performance.

The demographic information collected included gender, age, marital status, years of service, duties, and educational background. The questionnaire included 28 items divided into three dimensions: institutional adjustment, course activation, and employment promotion.

Research Design

The objective of the first stage was to investigate project implementation in senior high schools in Taiwan. Relevant domestic and foreign literature and reports were collected. The results were compiled for comprehensive generalization and analysis to confirm the study concepts and framework.

In the second stage, we met with experts to discuss the variables, constructs, and framework of the study and questionnaire development. Revisions were made based on their suggestions. The experts then examined the content validity of the questionnaire. The content was revised once more based on their opinions.

In the third stage, we adopted a quantitative approach, using document analysis and a questionnaire. The industry-demand-oriented questionnaire was developed based on expert opinions; it was then formally administered to samples representative of the population.

Participants

This study mainly examined attempts to reengineer industry-oriented technology education in senior high schools in Taiwan. Our participants were teachers of professional subjects in senior high schools in Taiwan. Below, we introduce the population and sampling principles.

Population

The sample population comprised the teachers of professional subjects in senior high schools in Taiwan.

Sampling methods

This study adopted purposive sampling. We contacted the principals, office directors, or teachers of various schools by phone and explained our research objectives and response methods to find schools willing to participate. We aimed for even distribution in northern, central, and southern Taiwan and finally decided on 21 senior high schools. A total of 945 questionnaires were distributed, with 742 valid questionnaires recovered. This represents a recovery rate of 78.50%.

Analysis

We selected samples based on their attributes and the locations of the schools. The formal questionnaire was conducted using purposive sampling. A total of 945 questionnaires were distributed, among which 742 valid questionnaires were recovered. The recovery rate was 78.50%. We then organized and coded questionnaire results for data entry. The data were then processed and analyzed using SPSS. We compiled descriptive statistics of demographic information to determine how responses differed according to relevant variables.

Each item in the questionnaire was a complete statement, and respondents were asked to indicate their level of agreement with the statements using a five-point Likert scale (1-strong disagreement, 2-disagreement, 3-neutral, 4-agreement, and 5-strong agreement).

Descriptive Analyses

The first part of the questionnaire collected the demographic information presented in **Table 3**. In terms of gender, 524 respondents were male and 218 respondents were female, which respectively accounted for 70.60% and 29.40% of the respondents. With regard to age, 94 respondents (12.70%) were 30 years old or younger; 256 respondents (34.50%) were between the ages of 31 and 40; 262 respondents (35.30%) were between the ages of 41 and 50; 122 respondents (16.40%) were between the ages of 51 and 60, and 8 respondents (1.10%) were 61 years old or older. In terms of marital status, 472 respondents (63.60%) were married, and 270 respondents (36.40%) were single. With regard to years of service at their schools, 168 respondents (22.60%) had served for 5 years or less, 170 respondents (22.90%) for 6 to 10 years, 142 respondents (19.10%) for 11 to 15 years, 94 respondents (12.70%) for 16 to 20 years, and 168 respondents (22.60%) for 21 years or more. With regard to their duties, 256 respondents (34.50%) also had administrative duties, whereas 486 respondents (65.50%) did not. In terms of educational background, 46 respondents (6.20%) had a junior college degree; 208 respondents (28.00%) had a bachelor's degree; 472 respondents (63.60%) had a master's degree, and 16 respondents (2.20%) had a doctoral degree. A total of 256 respondents (34.00%) expressed strong agreement with the claim that their school had actively participated in the project; 365 respondents (49.20%) agreed; 119 respondents (16.00%) had no opinion; 4 respondents (0.50%) indicated disagreement, and 2 respondents (0.30%) strongly disagreed.

Table 3. Demographic statistics

Background Variable	Gender			Age			Terms of marital status		
Category/Number of participants/Percentage	Male	524	70.60%	30 years old or younger	94	12.70%	married	472	63.60%
				31-40 years old	256	34.50%			
Total number of participants=587 Total percentage=100%	Female	218	29.40%	41-50 years old	262	35.30%	single	270	36.40%
				51-60 years old	122	16.40%			
				60 years old or older	8	1.10%			
Background Variable	**Duties**			**Years of service at their schools**			**Educational background**		
Category/Number of participants/Percentage	Administrative duties	256	34.50%	had served for 5 years or less	168	22.60%	junior college degree	46	6.20%
				for 6 to 10 years	170	22.90%	bachelor's degree	208	28.00%
Total number of participants=587 Total percentage=100%	did not	486	65.50%	for 11 to 15 years	142	19.10%	master's degree	472	63.60%
				for 16 to 20 years,	94	12.70%	doctoral degree	16	2.20%
				for 21 years or more	168	22.60%			

Table 4. Statistical analysis of questionnaire results (N=742)

Dimensions	Min	Max	Mean	SD
1. Institutional adjustment	**7.00**	**34.00**	**16.84**	**4.23**
1-1. Our school has established an effective communication platform for vocational and senior high schools, so administrative coordination is easier and more direct.	1	5	2.37	.77
1-2. Our school has concrete plans for academia-industry collaboration.	1	5	2.30	.78
1-3. Our school has established concrete technical exchange mechanisms to cultivate the talent required by the industry.	1	5	2.32	.77
1-4. Our school has a concrete understanding of industry demand and actively develops innovative planning mechanisms.	1	5	2.35	.78
1-6. The faculty at our school understands attempts to reengineer industry-oriented technology education and gives priority to key industries when granting subsidies.	1	5	2.45	.80
1-7. The faculty at our school understand the teacher appraisal (vocational high schools), faculty promotion (universities and colleges), and awards and grants mechanisms of the technology education system.	1	5	2.52	.85
1-8. The faculty at our school understand that the Technology Education Act stipulates that new teachers must have at least one year of practical work experience in an environment that is officially recognized by the central authority.	1	5	2.52	.89
2. Course activation	**10.00**	**48.00**	**21.96**	**5.89**
2-1. Our school plans professional courses based on industry demand.	1	5	2.34	.78
2-2. Our school encourages students to obtain professional and technical certificates based on industry demand.	1	5	1.95	.69
2-3. Our school has upgraded teaching equipment via the reengineering program for Industry-Oriented Technology Education.	1	5	2.04	.76
2-4. The teachers at our school coordinate the procured teaching equipment to best nurture the professional abilities in students that the industry needs.	1	5	2.04	.73
2-5. Our school invites industry experts to co-plan convergence courses.	1	5	2.29	.80
2-6. Our school plans courses and develops materials that are industry-demand-oriented.	1	5	2.28	.83
2-7. Our school plans industry-oriented practicum and featured courses.	1	5	2.23	.78
2-8. Our school focuses on industry demands so that students have practical abilities when they graduate.	1	5	2.38	.82
2-9. Our school hires industry experts to aid in teaching.	1	5	2.16	.85
2-10. The teachers currently teaching professional courses at our school have practical experience.	1	5	2.26	.80

Statistical Analyses

At least one respondent chose "strongly disagree," and at least one respondent chose "strongly agree," for each item so the minimum and maximum score values were 1 and 5 points, respectively. For the construct of institutional adjustment, the minimum and maximum scores were 7 and 34 points, respectively; in course activation, the minimum and maximum scores were 10 and 48 points; in employment promotion, the minimum and maximum scores were 10 and 50 points. Mean scores of the three constructs were 16.84, 21.96, and 23.59, respectively list in **Table 4**.

Table 4 (continued). Statistical analysis of questionnaire results (N=742)

Dimensions	Min	Max	Mean	SD
3. Employment promotion	**10.00**	**50.00**	**23.59**	**5.99**
3-1. The corporations that collaborate with our school give priority to our students when they are hiring.	1	5	2.29	.74
3-2. The corporations that collaborate with our school provide employment market information so that students understand industry needs.	1	5	2.26	.72
3-3. The corporations that collaborate with our school provide internship openings and plan for student practicum.	1	5	2.35	.80
3-4. Our school plans industry-oriented modular courses to provide students with immediate employability.	1	5	2.42	.81
3-5. Our school offers innovative entrepreneurship courses to cultivate innovative thinking in students.	1	5	2.37	.83
3-6. Our school assists winning entries of international invention competitions in commercialization.	1	5	2.70	.93
3-7. Our school holds campus recruiting events every year.	1	5	2.65	.99
3-8. Our school encourages students to obtain professional certificates corresponding to industry demands to benefit future employment.	1	5	2.04	.73
3-9. The number of students encouraged by our school to obtain professional certificates corresponding to industry demands is increasing annually.	1	5	2.15	.71
3-10. Our school holds various on-campus entrepreneurship promotion events and competitions to enhance the entrepreneurial skills of students.	1	5	2.36	.84

RESULTS

For institutional adjustment, items 1-7 and 1-8 presented the highest mean scores (M=2.52), while item 1-2 had the lowest mean score (M=2.30). For course activation, item 2-8 presented the highest mean score (M=2.38), whereas item 2-2 had the lowest mean score (M=1.95). For employment promotion, item 3-6 presented the highest mean score (M=2.70), whereas item 3-8 had the lowest mean score (M=2.04).

In terms of standard deviation, construct means and item means were all less than 3 points, which means that the senior high school teachers could identify with the items in the three constructs of the questionnaire. Only item 2-2 had a mean lower than 2 points, which shows a high degree of agreement in the remaining items.

For institutional adjustment, item 1-7 presented the highest standard deviation at 0.89, which means that the opinions of the 742 respondents were more divided with regard to this item. In contrast, item 1-1 had the lowest standard deviation at 0.77, which indicates greater consistency among the opinions of the 742 respondents in this item. For course activation, item 2-9 presented the highest standard deviation at 0.85, which means that the opinions of the 742 respondents were more divided with regard to this item. In contrast, item 2-2 had the lowest standard deviation at 0.69, which indicates greater consistency among the opinions of the 742 respondents in this item. For employment promotion, item 3-7 presented the highest standard deviation at 0.99, followed by item 3-6 with a standard deviation of 0.92. These results indicate that the opinions of the 742 respondents were more divided with regard to this item. In contrast, item 3-9 had the lowest standard deviation at 0.71, which indicates greater consistency among the opinions of the 742 respondents in this item.

No significant gender differences were found in the responses. In terms of standard deviation, construct means and item means were all less than 3 points, which suggests that the senior high school teachers could identify with the items in all three constructs of the questionnaire. Only item 2-2 had a mean lower than 2 points, which shows a high degree of agreement in the remaining items. On the whole, responses regarding feelings about reengineering project implementation in technology education varied significantly with the age of the respondent. We thus applied Scheffé's method but could not distinguish the cut off for differences. Responses regarding reengineering project implementation in technology education also varied significantly with years of service. We thus applied Scheffé's method and found that respondents that had served for 21 years or more (M=2.38) presented a significantly higher mean score than respondents that that had served for 5 years or less (M=2.20).

In **Table 5**, for institutional adjustment, the mean score presented by male respondents was 2.39, and the standard deviation was 0.62. In contrast, the mean score presented by female respondents was 2.44, and the standard deviation was 0.57. The F statistic of institutional adjustment was significant (0.64>0.05), which means that the data should be interpreted under the assumption of equal variance. The variance test result had greater significance than 0.5, whereas the Levene test of equal variance did not reach that level of significance. The F statistic was significant (0.27>0.05), which suggests that there were no significant differences (consistent) in the variances (divergence) of the male and female samples. We could thus assume equal variance. The results showed that $t(740) = -1.09$, $p>0.05$, and 95% CI[-1.02, 0.3]. The two-tailed significance was 0.27>0.05, which accepts H0 and indicates

Table 5. Independent t test results regarding gender

Dimensions	Analysis of variance					
	Gender	Sample	M	SD	t	p-value
Institutional adjustment	Male	524	2.39	.62	-1.09	.27
	Female	218	2.44	.57		
Course activation	Male	524	2.19	.61	-.42	.67
	Female	218	2.21	.53		
Employment promotion	Male	524	2.36	.62	-.26	.79
	Female	218	2.37	.54		

no significant differences between the responses made by the male and female respondents in institutional adjustment.

For course activation, the mean score presented by male respondents was 2.19, and the standard deviation was 0.61. In contrast, the mean score presented by female respondents was 2.21, and the standard deviation was 0.53. The F statistic for course activation was significant (0.11>0.05), and the variance test result was significantly greater than 0.5. The F statistic obtained from a Levene test of equal variance was significant (2.61>0.05), which means no significant differences (consistent) in the variances (divergence) of the male and female samples. We could thus assume equal variance. The results showed that t(740)=-0.42, p>0.05, and 95% CI[-1.08, 0.73]. The two-tailed significance was 0.67>0.05, which accepts H0 and indicates no significant differences between the responses made by the male and female respondents in course activation.

For employment promotion, the mean score presented by male respondents was 2.36, and the standard deviation was 0.62. In contrast, the mean score presented by female respondents was 2.37, and the standard deviation was 0.54. The F statistic of employment promotion was significant (0.11 >0.05), which means no significant differences (consistent) in the variances (divergence) of the male and female samples. We could thus assume equal variance. The results showed that t(740)=-0.26, p>0.05, and 95% CI[-1.03, 0.82]. The two-tailed significance was 0.79>0.05, which accepts H0 and indicates no significant differences between the responses made by the male and female respondents in employment promotion.

As shown in **Table 5**, the overall mean of scores given by women in the three dimensions (institutional adjustment, course activation, and employment promotion) were higher than that of scores given by men, which indicates that women were more likely to approve of the educational program changes than men.

The results in **Table 6** indicate significant differences among the responses made by different age groups on overall (F=4.27, p<.05). However, application of Scheffé's method could not distinguish the differences. The different age groups displayed no significant differences on the institutional adjustment level (F=2.30, p>.05). The different age groups displayed significant differences on the course activation level (F=4.06, p<.05). However, application of Scheffé's method could not distinguish the differences. The different age groups displayed no significant differences on the employment promotion level (F=4.88, p<.01). Scheffé's method showed that respondents between the ages of 41 and 50 (M=2.52) presented a significantly higher mean score in employment promotion than respondents that were 61 years or older (M=2.10) and those that were 30 years old or younger (M=2.15).

Table 6. Summary table of analysis of variance with regard to age on different factor levels

Dimensions	Analysis of variance						
Factor level	**Age**	**Sample**	**M**	**SD**	**F**	**p**	**Scheffé**
Institutional adjustment	(1) 30 years old or younger	94	2.31	.56	2.30	.06	
	(2) 31-40 years old	256	2.34	.60			
	(3) 41-50 years old	263	2.47	.58			
	(4) 51-60 years old	121	2.45	.62			
	(5) 60 years old or older	8	2.52	.98			
Course activation	(1) 30 years old or younger	94	2.05	.53	4.06**	.00	(3)>(1)
	(2) 31-40 years old	256	2.13	.55			
	(3) 41-50 years old	263	2.29	.60			
	(4) 51-60 years old	121	2.25	.61			
	(5) 60 years old or older	8	2.14	1.06			
Employment promotion	(1) 30 years old or younger	94	2.15	.53	4.88**	.00	
	(2) 31-40 years old	256	2.34	.61			
	(3) 41-50 years old	263	2.45	.60			
	(4) 51-60 years old	121	2.38	.58			
	(5) 60 years old or older	8	2.10	.74			
Overall	(1) 30 years old or younger	94	2.16	.48	4.27**	.00	
	(2) 31-40 years old	256	2.26	.54			
	(3) 41-50 years old	263	2.40	.54			
	(4) 51-60 years old	121	2.35	.55			
	(5) 60 years old or older	8	2.22	.85			

N=742; *p< .05; **p< .01

Table 7. Summary table of analysis of variance with regard to years of service

Dimensions	Analysis of variance						
Factor level	**Years of service**	**Sample**	**M**	**SD**	**F**	**P**	**Scheffé**
Institutional adjustment	(1) 5 years or less	168	2.33	.59	2.75*	.027	
	(2) 6-10 years	170	2.4	.66			
	(3)11-15 years	142	2.31	.56			
	(4) 16-20 years	94	2.43	.57			
	(5) 21 years or more	168	2.5	.61			
Course activation	(1) 5 years or less	168	2.09	.57	2.95*	.019	
	(2) 6-10 years	170	2.21	.60			
	(3)11-15 years	142	2.15	.56			
	(4) 16-20 years	94	2.29	.61			
	(5) 21 years or more	168	2.28	.60			
Employment promotion	(1) 5 years or less	168	2.22	.57	3.33*	.010	
	(2) 6-10 years	170	2.40	.60			
	(3)11-15 years	142	2.35	.60			
	(4) 16-20 years	94	2.46	.66			
	(5) 21 years or more	168	2.41	.57			
Overall	(1) 5 years or less	168	2.20	.53	3.36*	.010	(5)>(1)
	(2) 6-10 years	170	2.34	.57			
	(3)11-15 years	142	2.27	.52			
	(4) 16-20 years	94	2.39	.56			
	(5) 21 years or more	168	2.38	.54			

N=742; *p< .05; **p< .01

The results in Table 7 indicate significant differences overall among respondents that had served for different periods of time (F=3.36, p<.05). We thus applied Scheffé's method and found that respondents that had served for 21 years or more (M=2.38) presented a significantly higher mean score on the overall level than respondents that that had served for 5 years or less (M=2.20). Responses on the institutional adjustment level varied significantly with years of service (F=2.75, p<.05), as did those on the course activation level (F=2.95, p<.05) and the employment promotion level (F=3.33, p<.05). However, application of Scheffé's method on all three levels could not distinguish the differences.

DISCUSSIONS

Scheffé's method showed that respondents between the ages of 41 and 50 presented a significantly higher mean score in employment promotion than respondents that were 61 years or older and those that were 30 years old or younger.

On the whole, responses regarding attempts to reengineer technology education programs varied significantly with the age of the respondent. Results derived from Scheffé's method suggest that respondents that had served for 21 years or more presented a significantly higher mean score than respondents that that had served for 5 years or less.

Overall results, the overall mean of scores given by women for institutional adjustment, course activation, and employment promotion dimensions were higher than the scores given by men, which indicates that women were more likely to approve of the reengineering project than men.

Teachers play a very important role in educational activities, but they often don't know much about industry-oriented education and employment promotion. Therefore, in order to help students cultivate innovative thinking and improve their employability, both the government and the school must pay attention to the practical experience of teaching staff.

Schools must build channels for students to communicate and cooperate with enterprises. Corporations that collaborate with schools must provide employment market information so that students understand industry needs, and so schools can provide internship openings and plan for student practicum. Only with cooperation between schools and industry can the value of technology be maximized.

CONCLUSIONS

The objective of this study was to explore teacher's opionions about attempts to reengineer technology education programs at senior high schools in Taiwan. Technical and vocational education must work in tandem with industrial practice. The second phase for reengineering industry-oriented technology education ran from 2013 to 2017. The project appeared to have a positive impact on technical and vocational schools. In the second phase of the project, strategies for flexible courses, equipment renewal, practical skill upgrades, and employment convergence were implemented because they are directly associated with the cultivation of practical abilities needed in industry. The implementation of the reengineering project allowed technical and vocational schools in Taiwan have become more effective in cultivating professional skills in students and narrowing the industry-academia gap. We drew conclusions based on the analysis of our empirical results and formulated suggestions based on said conclusions to provide reference to schools, teachers, and administrative agencies in education.

The implementation of the education reengineering project helped to enhance the employability of students. However, current student tracking systems still lack complete data and information transparency. The implementation of this project also promoted knowledge-action integration and enhanced the practical abilities of teachers and students at technical and vocational schools. However, corporations should take some responsibility for talent cultivation; when graduates first enter corporations, vocational training and counseling can help novices immediately get on track for professional development.

1. In terms of institutional adjustment, the government should establish a cross-organization team to integrate government, industry, and school resources. Cultivation of industrial talent in Taiwan relies on institutions successfully implementing the regulations laid out in the Technical and Vocational Education Act.
2. In terms of course activation, technical and vocational high schools and colleges should develop curricula in collaboration with industry. Flexible course design and the connection and planning of interdisciplinary courses vary by school and require further improvement.
3. In terms of employment promotion, the greatest challenge at present is that many students are not willing to remain in the technology industry because they have other plans for their future.

The government of Taiwan is actively following a southbound policy, and many countries in Southeast Asia are in the take-off stage of economic growth. Technical and vocational education in Taiwan has cultivated considerable talent, and students in this education system have gained impressive achievements in various international competitions. We suggest that the government promote these successful experiences to countries throughout Southeast Asia and assist nearby countries in developing their national industry. This will prompt more solid development in Taiwan's technical and vocational education, promoting people-to-people diplomacy, thereby increasing the international influence of Taiwan's technical and vocational education system.

This study used both theoretical and practical perspectives to examine the implementation of the second phase for reengineering industry-oriented technology education in senior high schools in Taiwan. The results of this study provide reference for project assessment and administrative applications.

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