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Articles
Using ZigBee and Room-Based Location Technology to Construct a Ubiquitous Information Platform of Location-Based Service

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ABSTRACT

In recent years, as the advancement of mobile communication technology and popularization of information technology, diversified value-added services have emerged to offer a novel and comfortable living style for people. Location-Based Services (LBS) is an application integrating information and communication technology being developed rapidly in recent years. This study utilized a room-based indoor location model to construct a wireless sensor network location-oriented service platform. This platform could offer an indoor location service based on ZigBee technology. Through the location service, a Service Provider Gateway (SPG) pushes contents to users. Also, it was integrated with the school information system to achieve a ubiquitous campus. Based on the concept of LBS, the indoor location-oriented service could be realized by combining the ZigBee location technology and room-based location model, in order to achieve a ubiquitous campus environment. Users only need to utilize ZigBee Tag with Android smart phone, and a wireless network to log in this information platform, so as to enjoy the services of ubiquitous campus. The preliminary study has completed this information platform, and implemented it in this campus environment with satisfactory results.

Keywords: Location-based Service, Ubiquitous Information System, ZigBee Indoor Position, Intelligent System

INTRODUCTION

With the continuous improvement of communication technologies and increasing popularization of the information-based society, diversified mobile value-added services are developing rapidly. Ubiquitous is the representative of the modern information service, it is mainly composed of Any One, Any Time, Any Where, Any Thing and Any Device for General Platform of Location-Based Services (LBS) in Ubiquitous Environment (Xia, and Bae, 2007), indicating that any user can access Internet resource services by using any device and through the wireless network at anytime and anywhere. Therefore, after the concept of Ubiquitous was proposed, countries worldwide have actively promoted and constructed the ubiquitous environment, such as Microsoft's EasyLiving: Technologies for Intelligent Environments (Brumitt et al., 2000), Stanford's “The Interactive Workspaces Project: Experiences with Ubiquitous Computing Rooms” (Johanson et al., 2002), University of Tokyo's “Intelligent Space” (Lee et al. 1999), MIT's “Oxygen” and UC Berkeley's “Endeavour” (Satyanarayanan, 2001; Saha and Mukherjee, 2003), which all have realized the concept of Ubiquitous in real life. In recent years, Taiwan has been actively promoting the three milestones of information infrastructure, from “E-Taiwan” to “M-Taiwan”, and finally “U-Taiwan”. The attention of the Taiwanese government on the development of information infrastructure is obvious. “E-Taiwan” is to implement electronic applications to improve the efficiency; “M-Taiwan” is to expedite the speed by mobile devices; “U-Taiwan” is to achieve Ubiquitous and add real-time responses with environmental perception. Developed countries worldwide have been promoting the concept of Ubiquitous; hence, the information infrastructure has been improved with the implementation of programs. In the recent few years, a new concept, LBS was derived from Ubiquitous. Whether international or domestic research, to promote Taiwan's progress in real e-Learning, especially the Taiwan government in 2014 to promote a new generation of e-Learning program, therefore, for these reasons, the motivation of this study on Ubiquitous learning.

Yeh and Pan (2014) pointed that the ZigBee/IEEE 802.15.4 standards (IEEE, 2003; ZigBee, 2006) are proposed, which define physical, MAC, and network layers for low-rate, low-power wireless communications. For the reason that the purpose of this study aimed to construct an integrated platform of LBS. The front-end positioning of this platform...
uses ZigBee location technology and room-based location technology the previous work (Ordoñez et al., 2007; Yun et al., 2007) presents for indoor location search. The information service (e.g. school administration information system) provided by the backend information system is added to SPG through the Service Oriented Architecture (SOA) in Web Service mode, in order to realize the information flow mechanism of LBS.

LITERATURE REVIEW

LBS is an application of integrated technology of information service that has been developed rapidly in recent years. Its main concept is to provide personal and positional mobile service information according to users’ positions, and integrate the information, services and locations of services correspondingly, so that users can access information and services related to the site at any time from Exploring the Web as Value-Added Service for Location-Based Applications (Jakob et al., 2005). In short, LBS can answer and provide the following three types of information from J2ME and Location-Based Services (Sun Developer Network, 2008):

1. Where am I?
2. What services are available around me?
3. How can I get there?

In recent years, the rising concept of LBS has been discussed heatedly in Taiwan. However, it has already been implemented in other countries. The following gives an example to detail the mechanism LBS has two basic functions, one is collecting spatial and positioning information, the other one is providing services according to users' needs (Xiuwan et al., 2004). LBS has been applied widely at this stage, especially on outdoor services, such as satellite navigation for automobiles, Google Map and Google Earth by Google, and PaPaGo and Urmap e-mapss. Examples of such LBS Roaming Based on Web Services and Notification as a General-Purpose Services and emergency medical incidents (Wu, and Mei, 2005; Munson, and Gupta, 2002; Bohm et al., 2006; Maglogiannis, and Hadjieffthymiades, 2007).

According to the above examples, the advantages and potential of the integrated service application technology in the mobile value-added services are clear. However, detecting the users' positions is the key technology for realizing LBS application architecture. Examples of such design and implementation of a sensor network based location determination service for use in home networks or using geographical information systems (Ahmad et al., 2006; Sadoun, and Al-Bayari, 2007). This study incorporated the room-based indoor location function of ZigBee with the Service Provider Gateway (SPG) and the backend information system to realize the LBS platform.

The common indoor location technologies include RFID (Ting et al., 2006), Bluetooth (Flora et al., 2005), ZigBee (Marco et al., 2008; Ahmad et al., 2006), and Wi-Fi AP (Ciurana et al., 2007; Liu et al., 2007; Ekuhau, homepage, 2008). RFID provides short distance fixed-point positioning, mainly for small regions. Bluetooth is mainly at “room-level” (Coyle et al., 2006) in Healthcare Location Based Services, similar to RFID, it is limited to small regional services. ZigBee is a Wireless Sensor Network for medium distance sensing. Wi-Fi AP provides large-scale positioning and wide area services. However, each technology has its advantages and disadvantages, and applicable scope. Marco et al. (2008) presents at present, no single technology is applicable to all services and circumstances. Although RFID requires low cost, it is restricted to fixed-point positioning, and is unable to serve wide areas. Bluetooth has limits in network expansion and requires high power consumption. Wi-Fi requires more complicated software and hardware for positioning (Marco et al., 2008). This study used ZigBee as the technology for indoor location.

Adams (2004) presented ZigBee, which was a lightweight wireless sensing access network. Its communication standard is based on 802.15.4, working bands are 868MHz, 915MHz, and 2.4GHz. It technical features include low power consumption, low cost, flexible working band, and support to multiple network nodes. It is a two-way transmission wireless communication technology aiming at short distance, low complexity and low power consumption. It serves applications of low cost, low power consumption wireless sensor network and embedded network for remote monitoring, building control and building automation to industries and consumer markets. ZigBee can be embedded into various devices, and it supports positioning systems. The communication protocol of ZigBee standard definition can ensure wireless devices to complete transmission at low cost and low power. As ZigBee has reached a mature stage in sensing and application, it is applied in this study.

In conclusion, based on the concept of LBS, the indoor location-oriented service could be realized by combining the ZigBee location technology and room-based location model, in order to achieve a ubiquitous campus environment of education.

RESEARCH DESIGN AND IMPLEMENTATION

The primary purpose of this study aimed to construct a Ubiquitous Information Platform of Location-Based Service (UIPLBS) by using ZigBee and Room-based location technologies. Thus, the research design and implementation include construction of the UIPLBS as the major part of this study and the implementation of the experiment.

CONSTRUCTION OF A UBIQUITOUS PLATFORM OF LOCATION-BASED SERVICE (UIPLBS)

Room-based location

This study constructed a location-oriented service platform based on ZigBee location technology and room-based
location model. The room-based location model is different from general location modes that general location modes obtain users' position through algorithm according to the RSSI magnitude received at users' position. The room-based mode adopted in this study was combining the indoor location with ZigBee network. Room-based model regards the single spatial planning as a single service block, which can provide diversified related services of this region. When users enter this space, they are indicated by this spatial position. The information and services are provided through the backend information system by integrating with SPG, and sent back to users through the wireless network. Room-based location rule is to place a ZigBee node (referred to as secondary node) at the door (referred to as primary node) of each room and inside the room. The sensing distance of the node at the door is adjusted within 1.5m, and the antenna points inwards the room, so that the primary node would not sense unless the user tag passes through the door. The sensing distance of the node in the room is adjusted within 10m. When user tag passes the door of room and the secondary node in the room senses the user tag, it can be certain that the user is in this room. The following rules are added to the location model to improve the accuracy of room-based location.

Path rule

As shown in Figure 1, if the target is located at point B on the corridor, after some time t (t<time for location target moving to point A or point C) if the next location result is between point B and C, the results of points M and N behind the wall can be neglected. The path rule can neglect unreasonable location results, so as to improve the precision of location results effectively.

![Figure 1. Path rule](image)

Trajectory method

The movement of an object must be continuous, as shown in Figure 2. Point A must pass point B when moving to point C, if the interval of positioning time is less than the time for moving from point A to point B, the final location results can be modified according to location records. The precision of location results is improved effectively.

![Figure 2. Trajectory method](image)

Trigger event

As shown in Figure 3, reference point A is a trigger signal source (ZigBee Node), it sends out event trigger signals continuously when the target to be located passes through this area (circle with radius of 1m). ZigBee Tag is activated due to event trigger signals, and it collects the position information, such application can increase the timeliness of location, and increase the accuracy of trajectory method verifying and increase the precision of position fixing of particular point.

![Figure 3. Trigger event](image)
The following example is used to illustrate the above path rules and trajectory methods. As shown in Figure 5, if Room A is denoted by Node 1 and Node 2, respectively, Room B is denoted by Node 3 and Node 4, respectively, Room C is denoted by Node 5 and Node 6, respectively. Nodes 1, 3, 5 are primary nodes, located at the main entrance of the space, and Node 2, 4, 6 are secondary nodes, located in the space. According to the path rule, if the target to be measured is located at Node 1, then the possible node headed for at next time point must be Node 2, 3 or 5; however, according to the trajectory method, if the target to be measured is located at Node 2 and its destination is Node 6, then its path must be Node 2->1->5->6, Nodes 1 and 2 denote Room A; Nodes 3 and 4 denote Room B; Nodes 5 and 6 denote Room C, if the target enters Room A, the primary Node 1 will detect the target first, then the secondary Node 2 will also detect the target, when both Nodes 1 and 2 detect the target located within the range of signal, the positioning system will indicate the position of the target by Room A. Finally, setting is made through the rule setting interface of the front end positioning system based on this location rule. The interface is as shown in Figure.

**Figure 4. Location rule setting icons of ZigBee Noded arrangement**

**Figure 5. Schematic diagram of ZigBee Noded arrangement**

Based on the lab environment depicted in Figure 5, according to the path rule and trajectory method, the rule settings are as shown in Figure 4. The detailed steps of location rule setting are as follows:

- **Room A**: deployed with Node 1, 2. Node 1, 2 are set as one group and indicated by Room A space: Possible destination of Node 1 (primary node) at next time point is 2, 3, 5, Node 2 (secondary node) can only go to 1 at next time point.
- **Room B**: deployed with Node 3, 4. Node 3, 4 are set as one group and indicated by Room B space: Possible destination of Node 3 (primary node) at next time point is 1, 4, 5, Node 2 (secondary node) can only go to 3 at next time point.
- **Room C**: deployed with Nodes 5 and 6. Nodes 5 and 6 are set as one group, and indicated by Room C space: Possible destination of Node 5 (primary node) at next time point is 1, 3, 6, Node 6 (secondary node) can only go to 5 at next time point. Based on the above location rule setting, the room-based indoor location search is completed. The single spatial planning is regarded as a service unit to provide room-based indoor location-oriented service.

**System structure and operation**

The LBS platform implemented in this study is divided into three parts, including Location Positioning, Service Provider Gateway and Backend Information System, as shown in Figure 6. The details are described as follows.
Figure 6. System structure diagram Location Positioning

The main function is to combine the front-end mobile device with the ZigBee Tag module. User carry the ZigBee Tag placed under the ZigBee Node environment to integrate ZigBee with room-based location technology, in order to detect the network features through ZigBee. It uses the location module detection program to identify the ZigBee tag information and position, and sends back to ZigBee Location Server for storage.

Service Provider Gateway

Based on the Service Oriented Architecture (SOA), SPG contains five major modules, including Location Module, Application Module, Database Module, Management and Configuration Module and Web Service Module. Location module provides an interface for communication with ZigBee location server, and detects users' current position. Application module is the communication interface between SPG and mobile device, including Web-based operation interface of mobile device and location-oriented service server. Database module is mainly for storing Service Information and Service Log, so as to provide all records and information services of management platform. Management and Configuration module are responsible for the management and configuration of information platform, including service name, service specification, service list, and additional information, such as service log, and system parameter setting. Based on this module, administrators can conveniently monitor the utilization rate of various services and users' preferences. Web Service module is to combine backend with various service servers based on Web Service technology. Web Service module allows this platform architecture to integrate information with backend various information systems more easily and flexibly. As a result, more and diversified application services are rapidly delivered to users. The modules are shown in Figure 7.

Figure 7. SPG system function module graph

Location Module

This module provides an interface for communication between SPG and ZigBee Location Server, so that SPG and ZigBee Location Server can exchange information to obtain the position information of users. This module uses ZigBee technology to meet the demand for indoor location search. ZigBee Node is arranged in space, and uses the room-based mode for location positioning. ZigBee Node will send back the position of ZigBee tag detected by signal features to ZigBee Location Server through ZigBee network. Users' mobile device will lead the ZigBee tag information and relevant information of single user account to SPG through the front end integration program. SPG compares ZigBee tag information with ZigBee Location Server, reads the position corresponding to this ZigBee tag, and identifies the service area covering the users.

Application Module

The primary function of this module is to provide a bridge of communication between mobile devices and service servers, including user-friendly operating interface of mobile devices and location service oriented server. The main focus of application program uses Web-based as the basic architecture, and the main programming language is ASP.NET. Thus, users can find out the available services, and understand the full service process, thus enjoying a customized guide service. The client ends is Android smart phone.

Management and Configuration Module

This module mainly provides the interface of system management, parameter setting and service log, including the following parts.

A. ZigBee Tag information management

ZigBee Tag information management provides a management interface for system administrators to control the corresponding relationship between all users and their ZigBee tag ID. The management is to distribute a ZigBee tag for each system user in advance. Each ZigBee Tag has a set of unique Mac Address (namely tag ID). The system administrator writes the tag ID of each user in SPG database through this control interface in advance, based on the correspondence between users and tag ID, in order to provide the function of location-oriented service. When a user logs in the system and is verified at back end, SPG will read the Tag ID corresponding to the number of account inputted by the user in SPG database, and use this id as the basis for subsequent requests to ZigBee Location Server for the user's current position.

B. Service information management

The service information management provides this management interface to allow system administrators
controlling all services available to users, in order to make the information service item setting provided by the system more flexible. All information service items and contents provided for users are stored in the database module of SPG through this management interface. This study applied the module on the administration information system of this university, thus, the service items were university administration information.

C. Log management
The log management records the operation process of all services, and these logs can be used for analyzing the utilization rate of services, and operation and errors of the integrated system.

D. Personal customization management
The personal customization management provides a customization management service list for users, allowing them to select or reject the service items provided by SPG according to their preferences, select or reject the service items through the customized management interface selection, and modify the personal customization service list after the selections are sent to the SPG database. When a user logs on the system, his selected services would be shown on a list. Thus the customized service information services are ready for assessment.

Database Module
The database module stores the information used in the system, including Service Information, Personal Information, Service Log, and customized information.

Web Service Module
XML Web services (Web Services, homepage, 2008) provide the network service architecture. Its function is to register the services to the network and provide for online users. It adopts HTTP as the communication protocol and is based on the web application environment. The front end application program can request services from the backend web server through SOAP mode. The platform architecture of this study was able to realize flexible expansion of service information system based on the service mechanism of web services. The steps are as follows:

1) The backend service information platform can complete all service registrations based on UDDI (universal Description, Discovery, and Integration) standard, allowing the location service application server to search and use. Its main function is to generate centralized service contents.
2) Registered services can complete the description of services based on WSDL (Web services Description Language) standard, it is also a descriptive language based on XML to describe methods, parameters and types of feedback values supported by the Web services.
3) The communication between the location service application server and the backend service information system is completed by SOAP (Simple Object Access Protocol). SOAP is a mechanism for packing information, and its primary function is to let both ends be clear of the data format transferred.
4) Data transfer between two servers is in XML format.
5) Finally, the above information is transferred through HTTP protocol.

Based on the above steps, the backend service information system can be expanded flexibly, and all service registrations can be completed and service-related information can be recorded in the location service application platform. Then all the service information can be controlled efficiently from the platform.

Backend Information System
The backend information system in this study is the administration information system of Shu-Te University. As an example, it integrated services with SPG through web services technology, and displayed all services on users' mobile devices, transferred all information through SOAP communication and in XML format, in order to complete the mechanism provided by the backend information service. The operating process of information-integrated platform is shown in Figure 8.

![Figure 8. SPG Operation Model](image-url)
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5) When SPG receives the service request from the users, it sends a user position request to ZigBee Location Server, and detects the current position information of the user from the database of ZigBee Location Server according to the Tag ID corresponding to the user.

6) At the same time, SPG selects the service information from the backend information system through web services based on the service requests selected by the users.

7) Finally, the position oriented service items are sent back to the mobile device through wireless network, and presented to the users for browsing and selection. The flow mechanism of location-oriented service is realized.

Implementation of the experiment

The testing environment of this experiment was the Library and Information Building of this university, located at the 7th floor (Department of Information Engineering). ZigBee Nodes were placed in three classrooms, L0744, L0721 and L0725 according to the room-based location rule (see Figure 9), and the relations of these ZigBee Nodes were set in the location server according to rules stated in Section 2. The information services of the original university administration information system were converted into position-oriented services through this platform.

![Figure 9. Arrangement plan of ZigBee Node in the experimental environment](image)

The precision of indoor location is the key to evaluate service performance in this study. Therefore, the precision of the room-based location adopted by ZigBee was verified. The users with individual ZigBee Tags walk randomly in the experimental environment. The experiment involved five subjects each wearing a ZigBee Tag. Their locations were measured at the same time. The experimental time was divided into four periods, namely morning, noon, evening and midnight. In each period, the measurements on location were taken ten times, and the data were recorded, as shown in Table 1. The experimental data showed that the positioning time and the precision had high accuracy (accuracy rate) and efficient (mean delay time) by using ZigBee and Room-based location.

![Table 1. Measured data of ZigBee indoor location](table)

<table>
<thead>
<tr>
<th>Site of target</th>
<th>Measurements (Times)</th>
<th>Mean delay time</th>
<th>Accuracy rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>L0721</td>
<td>40</td>
<td>1.05 sec</td>
<td>95%</td>
</tr>
<tr>
<td>L0744</td>
<td>40</td>
<td>1.04 sec</td>
<td>95%</td>
</tr>
<tr>
<td>L0725</td>
<td>40</td>
<td>1.22 sec</td>
<td>95%</td>
</tr>
</tbody>
</table>

Next, the overall system platform was tested. The experiment used Android smart phone, and used a teacher's status to log in to this information platform for on-site measurement. The setting was at Classroom L0744. The simulation is detailed as follows:

1. Enter classroom in school hour: The teacher inputs the account number through the Android smart phone, and SPG judges the teacher's status according to the account number, and let the teacher select a service item (e.g. student list of this course). SPG transfers the time, site, service item and teacher's status to the backend information system through the web service. The backend information system sends back the lesson information to the teacher, and provides an e-roster for the teacher.

2. Enter classroom after school hour: The system sends back a list of all lessons in the semester to the teacher, and provides advanced services, such as browsing or make-up roll book.

Results of the experiment

The results of the experiment are as follows:
The user enters the system's login page through Android smart phone, input the user account number and password, and chooses the status to log in (the status is teacher in the experiment), as shown in Figure 10.

After login, the service list is displayed on the mobile device, and presented for the user to select service items, as shown in Figure 11. Click the classroom course query option to see the advanced service items.

From the information of time, site, status and service items, the teacher can view the course information, as shown in Figure 12, and click the roll call item to see the list of registered students in this course, as shown in Figure 13.
CONCLUSION AND SUGGESTIONS

Conclusion

This study presents an indoor location technology of wireless sensing network as the indoor location-oriented service, and applied it on the integration of campus information services, in order to construct a ubiquitous campus information platform through integrating the backend information system by using the features of ZigBee location technology and room-based location model. The goal was to provide a single platform integration mechanism to combine various backend service information platforms. Based on the Service Provider Gateway, users are able to access various services without connecting to multiple servers, and utilize services conveniently based on the convenience of Service Gateway Server. To complete the indoor location search by ZigBee location technology and room-based location mode, along with the mobile device and ZigBee tag module, this study could allow users to obtain all relevant position services to their specific locations within a short time, so as to achieve the ubiquitous information service. Hence, this study provides an effective method of e-Learning in the academic research.

In addition, this study also implemented together with the students, so that students learn by doing process, the concrete practice of ubiquitous information platform of location-based service. Meanwhile, the application of ZigBee technology research and teach students the concept of space, logic, drawing skills, programming, electronics technology, not only to enhance students' skills, to reinforce students' knowledge and attitudes. The experimental results proved that the precision of indoor location combining with ZigBee and room-based location model could reach 95%, if the travel speed too fast for the user, it will affect the use of precision measurement, so the actual measurement on a 5% error rate. The concept of planning single space as single unit could be applied to indoor location, in order to solve the problem of general signal characteristics on significant deviation in positioning results due to environmental variables or human factors. Future studies aim to expand the range of information service by combining this platform with outdoor location technology.

Suggestions

Although throughout a series of discreet design, a sound Ubiquitous Information Platform of Location-Based Service is constructed, the fact is that in order to effectively use technology for educational purposes, teachers need to be familiar and comfortable with use of ICT first. Thus, this newly developed platform should be implemented in a larger scale of experiments in the near future in order to explore its effect and users’ satisfaction.

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Do Teachers Understand the Motivations of Students and the Barriers to Starting a Business? A Comparison between Taiwan and the United States

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ABSTRACT

This study explores the differences toward entrepreneurial motivation and entrepreneurial barriers between teachers and students at technological universities in Taiwan. Data from Shinnar, Pruett, and Tonet (2009) are used to compare Taiwanese and American students. The results show that Taiwanese teachers and students do not differ in their opinions about entrepreneurial motivation, but they have distinct ideas about the entrepreneurial barriers for a startup business. Taiwanese teachers believe that lack of initial capital and excessive risk are the principal barriers for startup. Teachers ranked lack of experience in management and accounting lower on a scale than students did. To improve the effectiveness of entrepreneurship courses, teachers must understand the opinions of students, resolve their doubts, and encourage them to start a new business. Comparing the rankings of entrepreneurial motivation indicated that there are no cultural differences between Taiwanese and American students and teachers. However, traditional cultural differences regarding the value of individualism and the Chinese practice of inheriting the work of the father exist between Eastern and Western cultures. American students and teachers are more concerned with entrepreneurial barriers than are Taiwanese students and teachers, perhaps because American society places greater emphasis on personal freedom and an unwillingness to be held back, and the belief that starting a business involves an excessive amount of difficulties and obstacles. In Taiwan, more emphasis is placed on working hard, and Taiwanese believe that being the head of a small company is more favourable than being at the bottom of a large company. Because Taiwanese teachers and students agree that a startup business experiences difficulties and obstacles, these obstacles are not considered large barriers.

Keywords: Entrepreneurial Motivation, Entrepreneurial Barriers, Start a Business, Technical University

INTRODUCTION

Economists worldwide accept and recognize entrepreneurship as a catalyst to boost economic innovation and growth (Biju & Vardhan, 2011). Numerous government leaders regard entrepreneurship as a solution for economic depression (Gray, Foster, & Howard, 2006). When knowledge is not sufficient for generating income; creativity, innovation, and entrepreneurship must be developed in students. In recent years, government, industry, and schools in Taiwan have sought to cultivate an attitude of entrepreneurship among students. They have held competitions inside and outside of schools, such as the WeWin Entrepreneurial Competition, the TiC100 Entrepreneurial Competition, and the Rising Dragon Smile Competition. They have also established industry-academic cooperation centers, innovation incubator centers, and technical transfer or authorization centers, and increased industry-academia cooperation to develop entrepreneurship (Hsiao et al., 2012).

In the 1980s, 34.3% of university students were interested in starting a business in the United Kingdom (Wang & Wong, 2004). In the 1990s, 55% of university students and 66.9% of high-school students in the United States were interested in starting a new business. In Singapore, approximately 5.3% of university students were self-employed in the 1990s (Wang & Wong, 2004). According to the statistics of the U.S. Small Business Administration (SBA), two-thirds of university students considered entrepreneurship part of their career planning in 2001 (Shinnar, Pruett, & Tonet, 2009). Gong and Hsieh (2009) discovered that 51.8% university students of Chongqing University in China were interested in

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starting a new business. A survey by Gong (2011) showed that 32.3% of university students were willing to join a new startup business. In a survey on the entrepreneurial intentions of university students in Taiwan, Chen and Sung (2011) found that the entrepreneurial intention was at a medium level.

Entrepreneurial education has two objectives: (a) to increase the interest of students in starting businesses, and (b) to help students understand that starting a business is not a career choice (Auken, 2013). Auken (2013) discovered that studying entrepreneurship programs abroad improved the business and entrepreneurial skills of Spanish students. Rasmussen and Sorheim (2006) found that graduates who had received entrepreneurship program training are more likely and motivated to start a new business than other graduates are. However, studies that report contrary findings also exist (Gurel, 2010).

Tsai et al. (2008) proposed that if individuals had entrepreneurial competencies but lack motivation. Then, they may not be able to be successful entrepreneurs. Tsai et al. (2008) proposed is less likely to become a successful entrepreneur. Wu, Zhuang, and Hong (2012) surveyed 261 Taiwanese young people with fewer than 5 years of experience. They found that young people who are highly motivated to start a business are more likely to accomplish this goal.

Chen and Jing (2012) indicated that entrepreneurial education that is promoted in Taiwan is facing three problems: entrepreneurial management courses are not based in practice, the training of entrepreneurs is not comprehensive or diverse, and entrepreneurial competition tends to be competition for innovation. Yaghoubi (2010) suggested that problems in entrepreneurial education in Iran are inappropriate teaching methods, inappropriate educational content and syllabi, poor educational and laboratory equipment, and an inappropriate evaluation system. Khayri, Yaghoubi, and YazdaniPanch (2011) also indicated that these problems are unsuitable selection and training methods, inappropriate content and educational planning, communication barriers, lack of entrepreneurial training courses and books, and poor assessment and instructional programs. Education has a strong influence on the attitudes and aspirations of young people. Universities must teach students to understand how to develop potential businesses (Lütjhe & Prügl, 2008). The knowledge and skills of an entrepreneur are often not inherent; they must be taught (Harkema & Schout, 2008; Okudana & Rzasa, 2006). Chen et al. (2013) considered that entrepreneurship education not only teaches students to pursue an entrepreneurial career but also cultivates in students the entrepreneurship spirit and attitude to apply to their future jobs.

Chen and Jing (2012) indicated that it is possible to strengthen the curricular planning structure, course content, instructional resources and methods, and acquisition and compilation of practical instructional materials, and introduce teachers from industry to improve entrepreneurial education in Taiwan. Chang (2006) indicated that several entrepreneurial management courses in Taiwanese universities emphasize the development of theoretical foundations, but that teachers lack practical entrepreneurial experience. As a result, teachers are unable to share their knowledge of resolving possible startup problems with students.

Thus, before teaching a course on entrepreneurship, can teachers fully grasp student motivation? Do they understand the obstacles that students believe they will face when starting a business that may prevent them from becoming entrepreneurs? Can entrepreneurial education courses effectively inspire students to start a business?

This study is a continuation of the study by Chen et al. (2011), which was an analysis of the opinions of students on entrepreneurship. In this study, the views of teachers are added, and the differences among them are compared. Moreover, the opinions of teachers and students were compared to determine whether there are differences in their views of the motivation and barriers involved in starting a business, and whether there are differences in these views between American and Taiwanese teachers and students.

**Literature Review**

**Entrepreneurial Motivation**

Motivation for entrepreneurship has been the focus of several studies (Kirkwood & Walton, 2010). Entrepreneurial motivation is the core of the entrepreneurial process and affects personal behaviour during the business startup process (Chang & Cuiu, 2012). Pruett et al. (2009) indicated that entrepreneurial motivation positively influences entrepreneurial intentions. External events can influence entrepreneurial motivation (Wu, Zhuang, & Hong, 2012). Motivation promotes entrepreneurs to pursue or promote their objectives. Entrepreneurial motivation gives people the power to achieve their goals (Fan, Ou, & Wang, 2013). In other words, entrepreneurial motivation determines whether a person pursues and performs entrepreneurial activities (Shane, Locke, & Collins, 2003). The motivation of a person to become an entrepreneur is complex and multifaceted (Kirkwood & Walton, 2010).

Shane, Kolvereid, and Westhead (1991) indicated that entrepreneurial motivation can be divided into cognition motivation, independence motivation, learning motivation, and role motivation. Greenberger and Sexton (1988) suggested that a person’s motivations to engage in entrepreneurship include discovering opportunities in the market, believing that his or her operational model is more efficient than that of others, hoping to use his or her expertise to develop a new business, believing that his or her products can be profitable, desiring to realize his or her dream, and believing that entrepreneurship is the only path to wealth. Pruett et al. (2009) used factor analysis to identify five types of entrepreneurial motivation: financial status, quality of life, independence, creativity, and equal opportunity. Dubini (1989) divided entrepreneurial motivation into achievement, welfare, status, money, escape, freedom, and role models. Lin and Lee (2006) used factor analysis to summarize the five types of entrepreneurial motivation of female
entrepreneurs: self-actualization, social accomplishment, economic factors, self-fulfilment, and self-affirmation. McGhee, Kim, and Jennings (2007) divided entrepreneurial motivation into independence, contribution to community, and diversity. Kirkwood and Walton (2010) indicated that ecopreneurs were motivated by practicing their green values, earning a living, passion, being their own boss, and finding a gap in the market. They found that ecopreneurs, in addition to their motivation as ecologists, have similar motivation to other entrepreneurs. Hessels, Gelderen, and Thurik (2008) found that entrepreneurs desire to start a company because they are motivated by necessarily (e.g., not finding an ideal job), motivation for self-independence, and motivation for high profitability to increase personal wealth.

Benjamin and Philip (1986) summarized entrepreneurial motivation into pull factors and push factors. Pull factors are positive characteristics that make becoming an entrepreneur attractive, such as realizing potential business opportunities or the acquisition of personal patents. Push factors are negative factors that force workers out of their current jobs into entrepreneurship. Examples include dissatisfaction with the current job, corporate layoffs, and retrenchments because of business failures. Tsai et al. (2008) described pull factors as a combination of entrepreneurial motivation and internal resources (e.g., having professional know-how), and push factors as a combination of entrepreneurial motivation and environmental factors (e.g., closure of the original company).

Tsai et al. (2008) suggested that people who are strongly internally motivated are more willing to engage in risky, innovative, and entrepreneurial behaviours. Tyszka et al. (2011) found that the need for independence and the need for achievement are of higher importance to entrepreneurs than to non-entrepreneurs in Poland. McGhee, Kim, and Jennings (2007) found that women in farming families in the state of Virginia are more focused on expense-reducing activities than on income-generating activities, which were preferred by their male counterparts. Chang and Cuiu (2012) found that students who had more than 3 years of work experience had stronger entrepreneurial motivation.

Wu, Zhuang, and Hong (2012) surveyed 261 young people in Taiwan with fewer than 5 years of work experience. They discovered that, if pull entrepreneurial motivation is high, then the intention to start a business is also high. No significant correlation existed between push motivation and entrepreneurial intention. Gong (2011) indicated that the most valued three types of motivation for Beijing university students to start a business are to realize personal ideas and the desire to be their own boss and financially prosper. Chen et al. (2011) found that the top three types of motivation for technical students in Taiwan are to create products of their own, to implement their own ideas, and to achieve personal independence. Pruitt et al. (2009) indicated that the top three types of entrepreneurial motivation in the United States and China are to implement original ideas, achieve personal independence, and create innovative products. Students in Spain are motivated to start a business because they can implement their own ideas, create innovative products, and achieve personal independence. Shinnar et al. (2009) surveyed 317 students and 84 faculty members at a comprehensive 4-year public university in the United States and indicated that students and faculty members agree that the top two motivational factors for entrepreneurship are the chance to implement their own ideas and achieve personal independence. Brancu, Munteanu, and Gligor (2012) indicated that the top five types of motivation of third-year university students in Romania are to earn a high income, develop their own ideas, improve their skills, validate their own abilities, and avoid unemployment.

Entrepreneurial Barriers

Pruett et al. (2009) argued that entrepreneurial barriers negatively affect entrepreneurial intention. They used factor analysis to summarize the five entrepreneurial barriers, which are support structure, knowledge, operating risks, startup risk, and self-efficacy and support. Lin and Lee (2006) demonstrated that the main entrepreneurial barriers that female entrepreneurs encounter are lack of funding, lack of understanding of market changes, and the mental and physical strain of running a startup business.

Gong (2011) found that the top two entrepreneurial barriers in China are lack of entrepreneurial culture and insufficient personal entrepreneurial knowledge. Chinese entrepreneurial education is utilitarian because it involves relieving employment pressure, offering solutions to the lack of startup funds, and providing guidance for entrepreneurship. Chen et al. (2011) indicated that the top three barriers of starting a business for technical students in Taiwan are a lack of initial capital, business and market knowledge, and high-level entrepreneurial competence. Gong (2011) surveyed 678 students from 29 universities in Beijing and found that the top three entrepreneurial barriers are a lack of entrepreneurial knowledge, insufficient funds, and a lack of work experience.

Shinnar et al. (2009) surveyed 317 U.S. university students and found that the top five barriers are risk, lack of capital, economic situation, lack of competence, and lack of knowledge. Pruitt et al. (2009) found that startup barriers for students in the United States, China, and Spain are different. The top three barriers for U.S. and Spanish students are excessive risk, lack of initial capital, and economic situation. The top three barriers for Chinese students are excessive risk, lack of initial capital, and lack of ideas for the business. Research has shown that most students are not inclined to start a new business before they have sufficient funds. In addition, education does not promote the entrepreneurial spirit. As a result, students believe that they lack entrepreneurial knowledge, making them unwilling to start a business. Young people constrained by their lack of work experience; therefore, they face greater entrepreneurial barriers than older people do.

METHODOLOGY

The purpose of this study is to investigate Taiwanese technical students’ perceptions of entrepreneurial motivation.
and barriers to starting a business. A questionnaire was used to collect data. The survey instrument was originally developed at the University of Alicante, Spain, and translated into English by Shinnar et al. (2009). We translated the English version into Chinese. The survey consisted of five-point Likert scale, that with "5" as the highest and "1" as the lowest.

The samples of this study were selected from students of marketing- and logistics-management-related departments from 34 technical universities in Taiwan. Because graduates of these departments were more likely to engage in starting a business, especially for franchise businesses, that were very popular in Taiwan (Hsiao et al., 2012). We delivered 1,360 questionnaires to 34 departmental chairpersons, who assisted in distributing them to students at their respective universities. The departmental chairpersons led to the creation of entrepreneurship courses, so we asked departmental chairpersons to complete a questionnaire. We received the completed questionnaires from 22 universities. After eliminating those with incomplete answers and invalid copies, a total of 847 valid copies were received from students and 22 valid copies were received from departmental chairpersons. The valid return rate for students was 64.16%.

The participation of Shinnar et al. (2009) study were 317 students, 186 men (58.6%) and 131 women 41.4%. There were 60.4% were business majors, 38.6% were majors in other fields, and approximately 1% did not have a declared major and were included as nonbusiness majors. In addition, 13% were freshmen, 10.4% sophomores, 32% juniors, and 44.6% seniors. Among the 87 faculty members, there were 22 (25.3%) lecturers, 22 (25.3%) assistant professors, 26 (29.8%) associate professors, and 17 (19.6%) full professors. The average age was 48.6 years ($SD= 10.9$ years), ranging from 27 to 77 years. In terms of academic affiliation, 20 (23%) were in the college of business, and the remaining 67 (77%) were from a wide range of disciplines.

As to the background of our 847 samples, there were 310 male students (36.6%) and 537 (63.4%) were female. There were 85 (10.0%) students were freshman, 330(39.0%) were sophomore, 371(43.8%) were junior and 61 (7.2%) were senior. There were 118 (13.9%) students studied in public schools and 729 (86.1%) studied in private schools. There were 439 (51.8%) students studied in universities of technology and 408 (48.2%) studied in institutes of technology (47.8%). There were 718 (84.8%) had work-study experience, 129 (15.2%) did not have work-study experience. There were 150(17.78%) students’ parents had entrepreneurial experience and 697 (82.3%) did not have. Only 286 students had the intention to start a business in the future, whereas 561 did not intend to start a business in the future. It is shown in Table 1.

<table>
<thead>
<tr>
<th>Table 1. Background of samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
</tr>
<tr>
<td>Gender</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Grade</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
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<tr>
<td></td>
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<tr>
<td>Properties</td>
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<tr>
<td></td>
</tr>
<tr>
<td>Level</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Work-study experience</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Entrepreneurial experience of parents</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Entrepreneurial intention</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

The entrepreneurial motivation for business entrepreneurship among students was assessed and compared with the responses from departmental chairpersons.

A cross-national comparison was conducted using the study by Shinnar et al. (2009). The comparison was performed by calculating the means, standard deviations, and sample numbers of the two studies, and by computing the $t$ value as shown in the following equation:
The 286 have students who reported entrepreneurial intentions ranked their top three motivating factors to start their own business as "creating something of my own," "the chance to implement my own ideas," and "personal independence." Although valued, money was not one of the top three motivating factors. The bottom three motivating factors for starting a business were "following a family tradition," "the difficulty of finding the right job," and "gaining high social status".

Teachers shared the top three motivating factors to start a business with their students. However, the bottom three motivating factors, from most to least important, were "the difficulty of finding the right job," "following a family tradition," and "managing people." Kendall's Tau coefficient was 0.79, p < .00, indicating that teachers and students in Taiwan have consistent rankings in entrepreneurial motivation and report only minor differences, as shown in Table 2.

However, in Table 2, students ranked "gaining high social status" thirteenth, whereas teachers ranked it eighth. This shows that teachers believe that entrepreneurs easily improve their social status. However, technical university students generally start micro-firms, which do not contribute to improving social status. Therefore, students are less likely than teachers to believe that social status is a strong motivation for starting a business.

Table 2. Motivations for Startup business

<table>
<thead>
<tr>
<th>Motivation</th>
<th>Student</th>
<th>Teacher</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creating something of my own</td>
<td>4.34</td>
<td>4.591</td>
<td>1.67</td>
</tr>
<tr>
<td>The chance to implement my own ideas</td>
<td>4.25</td>
<td>4.409</td>
<td>1.06</td>
</tr>
<tr>
<td>Personal independence</td>
<td>4.23</td>
<td>4.318</td>
<td>0.57</td>
</tr>
<tr>
<td>Building personal wealth</td>
<td>4.06</td>
<td>3.955</td>
<td>-0.52</td>
</tr>
<tr>
<td>Being at the head of an organization</td>
<td>4.04</td>
<td>4.182</td>
<td>0.76</td>
</tr>
<tr>
<td>The opportunity to be financial independent</td>
<td>4.03</td>
<td>4.136</td>
<td>0.59</td>
</tr>
<tr>
<td>Improving my quality of life</td>
<td>3.84</td>
<td>3.409</td>
<td>-2.11*</td>
</tr>
<tr>
<td>Dissatisfaction in a professional occupation</td>
<td>3.63</td>
<td>3.227</td>
<td>-1.79</td>
</tr>
<tr>
<td>Receiving fair compensation</td>
<td>3.63</td>
<td>3.318</td>
<td>-1.55</td>
</tr>
<tr>
<td>Managing people</td>
<td>3.59</td>
<td>3.091</td>
<td>-2.12*</td>
</tr>
<tr>
<td>Making more money than by working for wages</td>
<td>3.58</td>
<td>3.136</td>
<td>-2.08*</td>
</tr>
<tr>
<td>Having more free time</td>
<td>3.57</td>
<td>3.136</td>
<td>-1.75</td>
</tr>
<tr>
<td>Gaining high social status</td>
<td>3.48</td>
<td>3.364</td>
<td>-0.54</td>
</tr>
<tr>
<td>The difficulty of finding the right job</td>
<td>3.48</td>
<td>2.773</td>
<td>-3.35***</td>
</tr>
<tr>
<td>Following a family tradition</td>
<td>3.30</td>
<td>3.045</td>
<td>-1.30</td>
</tr>
</tbody>
</table>

\(p < 0.05 \quad ^*p < 0.01 \quad ^{**}p < 0.001\)

Table 3 shows a comparison of the top three factors that motivate Taiwanese and U.S. students to start a business. For U.S. students, the top three factors were "the chance to implement my own ideas," "personal independence," and "creating something of my own." Although the top three motivating factors were the same as those of Taiwanese students, the ranking is not the same. For Taiwanese students "creating something of my own" was the top motivating factor, whereas U.S. students were most concerned with "the chance to implement my own ideas."

Kendall's Tau coefficient was 0.714, and \(p < .001\), which shows that rankings of Taiwanese and American students were considerably consistent because they share similar views about entrepreneurial motivation.

Table 3. Motivations for Startup business of Students compared with Taiwan and U.S.

\[
S_{p}^{2} = \frac{(N_{1}-1)S_{1}^{2} + (N_{2}-1)S_{2}^{2}}{N_{1} + N_{2} - 2}
\]

\[
t = \frac{S_{p}^{2} / N_{1} + S_{p}^{2} / N_{2}}{X_{2} - X_{1}}
\]
Taiwanese teachers ranked the following factors as the top three motivations for starting a business: “creating something of my own,” “the chance to implement my own ideas,” and “personal independence.” The top three motivating factors for U.S. teachers were “personal independence,” “the chance to implement my own ideas,” and the “opportunity to be financial independent.” Kendall's Tau coefficient was 0.543, and p < .001, which shows that the rankings of the opinions on entrepreneurial motivation of Taiwanese and American teachers were consistent. Comparing the t-values of the motivating factors “creating something of my own” and “gaining high social status” indicated that Taiwanese teachers feel more strongly about the ability of an entrepreneur to gain social status than American teachers do, as shown in Table 4.

### Table 4 Motivations for Startup Business of Teacher

<table>
<thead>
<tr>
<th>Motivation</th>
<th>Taiwan M</th>
<th>Taiwan SD</th>
<th>Taiwan Rank</th>
<th>U.S. M</th>
<th>U.S. SD</th>
<th>U.S. Rank</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creating something of my own</td>
<td>4.59</td>
<td>0.503</td>
<td>1</td>
<td>3.98</td>
<td>1.113</td>
<td>4</td>
<td>-2.45*</td>
</tr>
<tr>
<td>The chance to implement my own ideas</td>
<td>4.41</td>
<td>0.503</td>
<td>2</td>
<td>4.38</td>
<td>1.011</td>
<td>2</td>
<td>-0.14</td>
</tr>
<tr>
<td>Personal independence</td>
<td>4.32</td>
<td>0.716</td>
<td>3</td>
<td>4.43</td>
<td>1.024</td>
<td>1</td>
<td>0.49</td>
</tr>
<tr>
<td>Being at the head of an organization</td>
<td>4.18</td>
<td>0.733</td>
<td>4</td>
<td>3.70</td>
<td>1.095</td>
<td>5</td>
<td>-1.88</td>
</tr>
<tr>
<td>The opportunity to be financial independent</td>
<td>4.14</td>
<td>0.710</td>
<td>5</td>
<td>3.99</td>
<td>1.038</td>
<td>3</td>
<td>-0.65</td>
</tr>
<tr>
<td>Building personal wealth</td>
<td>3.96</td>
<td>0.899</td>
<td>6</td>
<td>3.67</td>
<td>1.009</td>
<td>7</td>
<td>-1.24</td>
</tr>
<tr>
<td>Improving my quality of life</td>
<td>3.41</td>
<td>0.796</td>
<td>7</td>
<td>3.68</td>
<td>1.150</td>
<td>6</td>
<td>0.95</td>
</tr>
<tr>
<td>Gaining high social status</td>
<td>3.37</td>
<td>0.953</td>
<td>8</td>
<td>2.62</td>
<td>0.978</td>
<td>15</td>
<td>-3.31***</td>
</tr>
<tr>
<td>Receiving fair compensation</td>
<td>3.32</td>
<td>1.041</td>
<td>9</td>
<td>3.10</td>
<td>0.982</td>
<td>11</td>
<td>-0.93</td>
</tr>
<tr>
<td>Dissatisfaction in a professional occupation</td>
<td>3.23</td>
<td>1.020</td>
<td>10</td>
<td>3.09</td>
<td>1.112</td>
<td>12</td>
<td>-0.49</td>
</tr>
<tr>
<td>Making more money than by working for wages</td>
<td>3.14</td>
<td>0.834</td>
<td>11</td>
<td>3.59</td>
<td>1.122</td>
<td>8</td>
<td>1.64</td>
</tr>
<tr>
<td>Having more free time</td>
<td>3.14</td>
<td>1.125</td>
<td>12</td>
<td>2.62</td>
<td>1.223</td>
<td>14</td>
<td>-1.50</td>
</tr>
<tr>
<td>Managing people</td>
<td>3.10</td>
<td>0.868</td>
<td>13</td>
<td>2.87</td>
<td>0.939</td>
<td>13</td>
<td>-1.12</td>
</tr>
<tr>
<td>Following a family tradition</td>
<td>3.05</td>
<td>0.785</td>
<td>14</td>
<td>3.31</td>
<td>1.109</td>
<td>9</td>
<td>1.00</td>
</tr>
<tr>
<td>The difficulty of finding the right job</td>
<td>2.78</td>
<td>1.066</td>
<td>15</td>
<td>3.13</td>
<td>0.933</td>
<td>10</td>
<td>1.58</td>
</tr>
</tbody>
</table>

*p < 0.05  **p < 0.01  ***p < 0.001
For the 561 students who did not have intentions of becoming entrepreneurs, the top three entrepreneurial barriers for starting a business were "lack of initial capital," "lack of knowledge of the business world and the market," and "lack of a high level of entrepreneurial competence." The bottom three entrepreneurial barriers were "having to work too many hours," "lack of support from family and friends," and "doubts about personal abilities." The top three entrepreneurial barriers for Taiwan teachers were "lack of initial capital," "excessive risk," and "irregular income." The bottom three entrepreneurial barriers for Taiwanese teachers were "lack of experience in management and accounting," "lack of support from family and friends," and "having to work too many hours." The results are shown in Table 5.

Testing the $t$ values indicated that Taiwanese teachers ranked the entrepreneurial barriers "lack of initial capital" and "excessive risk" higher than students did. Students ranked "lack of experience in management and accounting" higher than teachers did. Kendall's Tau coefficient was 0.242, and $p > .05$, which shows that Taiwanese teachers and students ranked entrepreneurial barriers differently.

### Table 5. Barriers for startup business

<table>
<thead>
<tr>
<th></th>
<th>Student M</th>
<th>Student SD</th>
<th>Student Rank</th>
<th>Teacher M</th>
<th>Teacher SD</th>
<th>Teacher Rank</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of initial capital</td>
<td>3.66</td>
<td>0.956</td>
<td>1</td>
<td>4.27</td>
<td>0.550</td>
<td>1</td>
<td>3.15**</td>
</tr>
<tr>
<td>Lack of knowledge of the business world and the market</td>
<td>3.43</td>
<td>0.970</td>
<td>2</td>
<td>3.14</td>
<td>1.125</td>
<td>6</td>
<td>-1.40</td>
</tr>
<tr>
<td>Lack of a high level of entrepreneurial competence</td>
<td>3.42</td>
<td>1.008</td>
<td>3</td>
<td>3.10</td>
<td>1.109</td>
<td>9</td>
<td>-1.44</td>
</tr>
<tr>
<td>Lack of experience in management and accounting</td>
<td>3.37</td>
<td>0.999</td>
<td>4</td>
<td>2.73</td>
<td>0.985</td>
<td>12</td>
<td>-2.95**</td>
</tr>
<tr>
<td>Lack of ideas regarding what business to start</td>
<td>3.29</td>
<td>1.000</td>
<td>5</td>
<td>3.27</td>
<td>0.985</td>
<td>4</td>
<td>-0.09</td>
</tr>
<tr>
<td>Current economic situation</td>
<td>3.29</td>
<td>0.992</td>
<td>6</td>
<td>3.10</td>
<td>1.109</td>
<td>8</td>
<td>-0.88</td>
</tr>
<tr>
<td>Excessively risky</td>
<td>3.28</td>
<td>0.961</td>
<td>7</td>
<td>3.73</td>
<td>0.767</td>
<td>2</td>
<td>2.27***</td>
</tr>
<tr>
<td>Irregular income</td>
<td>3.10</td>
<td>1.010</td>
<td>8</td>
<td>3.46</td>
<td>0.800</td>
<td>3</td>
<td>1.65</td>
</tr>
<tr>
<td>Fear of failure</td>
<td>2.91</td>
<td>1.092</td>
<td>9</td>
<td>3.14</td>
<td>0.941</td>
<td>5</td>
<td>0.90</td>
</tr>
<tr>
<td>Doubts about personal abilities</td>
<td>2.90</td>
<td>1.107</td>
<td>10</td>
<td>3.14</td>
<td>1.037</td>
<td>7</td>
<td>0.91</td>
</tr>
<tr>
<td>Lack of support from family, friends</td>
<td>2.83</td>
<td>1.014</td>
<td>11</td>
<td>2.73</td>
<td>0.883</td>
<td>11</td>
<td>-0.45</td>
</tr>
<tr>
<td>Having to work too many hours</td>
<td>2.71</td>
<td>0.979</td>
<td>12</td>
<td>3.00</td>
<td>0.926</td>
<td>10</td>
<td>1.40</td>
</tr>
</tbody>
</table>

$p < 0.05$ **$p < 0.01$ **

As shown in Table 6, U.S. students ranked the following four factors as the main entrepreneurial barriers for starting a business: "excessive risk," "lack of capital," "economic situation," and "lack of competence and knowledge." The bottom three entrepreneurial barriers for U.S. students were "doubts about personal abilities," "having to work too many hours," and "fear of failure."

Although there were differences between American and Taiwanese students, Kendall's Tau coefficient was 0.545, and $p < .001$. This shows that they are highly consistent in their rankings, and minor differences occurred in their views on entrepreneurial barriers. Comparing the $t$ values showed that U.S. students ranked entrepreneurial barriers significantly higher than Taiwanese students did, which shows that members of U.S. society value personal freedom and are less willing to be constrained by the difficulties and obstacles of starting a business.

### Table 6. Barriers for startup business of Student

<table>
<thead>
<tr>
<th></th>
<th>Taiwan M</th>
<th>Taiwan SD</th>
<th>Taiwan Rank</th>
<th>U.S. M</th>
<th>U.S. SD</th>
<th>U.S. Rank</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of initial capital</td>
<td>3.66</td>
<td>0.956</td>
<td>1</td>
<td>4.18</td>
<td>1.442</td>
<td>2</td>
<td>5.55***</td>
</tr>
<tr>
<td>Lack of knowledge of the business world and the market</td>
<td>3.43</td>
<td>0.970</td>
<td>2</td>
<td>3.70</td>
<td>1.089</td>
<td>6</td>
<td>3.73***</td>
</tr>
<tr>
<td>Lack of a high level of entrepreneurial competence</td>
<td>3.42</td>
<td>1.008</td>
<td>3</td>
<td>3.86</td>
<td>1.008</td>
<td>4</td>
<td>6.16***</td>
</tr>
<tr>
<td>Lack of experience in management and accounting</td>
<td>3.37</td>
<td>0.999</td>
<td>4</td>
<td>3.76</td>
<td>0.998</td>
<td>5</td>
<td>5.57***</td>
</tr>
<tr>
<td>Lack of ideas regarding what business to start</td>
<td>3.29</td>
<td>1.000</td>
<td>5</td>
<td>3.68</td>
<td>2.723</td>
<td>7</td>
<td>1.67</td>
</tr>
<tr>
<td>Current economic situation</td>
<td>3.29</td>
<td>0.992</td>
<td>6</td>
<td>4.18</td>
<td>0.881</td>
<td>3</td>
<td>13.9***</td>
</tr>
<tr>
<td>Excessively risky</td>
<td>3.28</td>
<td>0.961</td>
<td>7</td>
<td>4.25</td>
<td>0.843</td>
<td>1</td>
<td>16.3***</td>
</tr>
<tr>
<td>Irregular income</td>
<td>3.10</td>
<td>1.010</td>
<td>8</td>
<td>3.65</td>
<td>0.971</td>
<td>8</td>
<td>7.89***</td>
</tr>
<tr>
<td>Fear of failure</td>
<td>2.91</td>
<td>1.092</td>
<td>9</td>
<td>3.44</td>
<td>1.209</td>
<td>10</td>
<td>5.85***</td>
</tr>
<tr>
<td>Doubts about personal abilities</td>
<td>2.90</td>
<td>1.107</td>
<td>10</td>
<td>3.37</td>
<td>1.220</td>
<td>12</td>
<td>5.07***</td>
</tr>
</tbody>
</table>

18
Taiwanese and U.S. teachers ranked entrepreneurial barriers differently. As shown in Table 7, the top three entrepreneurial barriers for U.S. teachers were “lack of initial capital,” “lack of a high-level entrepreneurial competence,” and “excessive risk.” The bottom three entrepreneurial barriers for U.S. teachers were “lack of ideas regarding which business to start,” “lack of support from family and friends,” and “doubts about personal abilities.” Kendall's Tau coefficient was 0.333, indicating that Taiwanese and U.S. teachers have considerably different views on entrepreneurial barriers. A comparison of t-values showed that U.S. teachers perceived stronger entrepreneurial barriers than did Taiwanese teachers. They perceived that entrepreneurial barriers produce a greater effect on an entrepreneur’s intention to start a business.

Table 7. Barriers for startup business of Teacher

<table>
<thead>
<tr>
<th>Barriers for startup business</th>
<th>Taiwan M</th>
<th>Taiwan SD</th>
<th>Taiwan Rank</th>
<th>U.S. M</th>
<th>U.S. SD</th>
<th>U.S. Rank</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of initial capital</td>
<td>4.27</td>
<td>0.550</td>
<td>1</td>
<td>4.45</td>
<td>0.967</td>
<td>1</td>
<td>0.93</td>
</tr>
<tr>
<td>Excessively risky</td>
<td>3.73</td>
<td>0.767</td>
<td>2</td>
<td>4.14</td>
<td>0.957</td>
<td>3</td>
<td>2.01*</td>
</tr>
<tr>
<td>Irregular income</td>
<td>3.46</td>
<td>0.800</td>
<td>3</td>
<td>3.84</td>
<td>0.999</td>
<td>5</td>
<td>1.71</td>
</tr>
<tr>
<td>Lack of ideas regarding what business to start</td>
<td>3.27</td>
<td>0.985</td>
<td>4</td>
<td>3.34</td>
<td>1.340</td>
<td>12</td>
<td>0.18</td>
</tr>
<tr>
<td>Fear of failure</td>
<td>3.14</td>
<td>0.941</td>
<td>5</td>
<td>3.83</td>
<td>1.178</td>
<td>6</td>
<td>2.24*</td>
</tr>
<tr>
<td>Lack of knowledge of the business world and the market</td>
<td>3.14</td>
<td>1.125</td>
<td>6</td>
<td>4.11</td>
<td>1.004</td>
<td>4</td>
<td>0.20</td>
</tr>
<tr>
<td>Doubts about personal abilities</td>
<td>3.14</td>
<td>1.037</td>
<td>7</td>
<td>3.58</td>
<td>0.925</td>
<td>10</td>
<td>2.04*</td>
</tr>
<tr>
<td>Current economic situation</td>
<td>3.10</td>
<td>1.109</td>
<td>8</td>
<td>3.74</td>
<td>1.088</td>
<td>8</td>
<td>2.24*</td>
</tr>
<tr>
<td>Lack of a high level of entrepreneurial competence</td>
<td>3.10</td>
<td>1.109</td>
<td>9</td>
<td>4.21</td>
<td>0.910</td>
<td>2</td>
<td>5.10***</td>
</tr>
<tr>
<td>Having to work too many hours</td>
<td>3.00</td>
<td>0.926</td>
<td>10</td>
<td>3.60</td>
<td>1.208</td>
<td>9</td>
<td>1.87</td>
</tr>
<tr>
<td>Lack of support from family, friends</td>
<td>2.73</td>
<td>0.883</td>
<td>11</td>
<td>3.49</td>
<td>1.073</td>
<td>11</td>
<td>2.95**</td>
</tr>
<tr>
<td>Lack of experience in management and accounting</td>
<td>2.73</td>
<td>0.985</td>
<td>12</td>
<td>3.76</td>
<td>1.100</td>
<td>7</td>
<td>3.70***</td>
</tr>
</tbody>
</table>

**p<0.05  *p<0.01  ***p<0.001

CONCLUSION AND LIMITATIONS

This study produced three key findings. First, according to technical students in Taiwan, the top three entrepreneurial motivating factors for starting a business are “creating something of my own,” “the chance to implement my own ideas,” and “personal independence.” The top three entrepreneurial motivating factors for Taiwanese teachers were the same. Taiwanese teachers and students have exhibited considerable similarities in the ranking of entrepreneurial motivating factors. Further comparison with the study by Shinnar et al. (2009) shows no significant differences among Taiwanese and U.S. teachers and students in their overall rankings for entrepreneurial motivation. This shows that no cultural differences exist in the views on entrepreneurial motivation. However, comparing the t-values showed that U.S. students place more emphasis on personal values, and thus ranked “the chance to implement my own ideas” and “personal independence” higher than Taiwanese students did. Taiwanese students ranked “gaining high social status” and “following a family tradition” higher than U.S. students did. This shows that, in Taiwanese society, entrepreneurship is more likely to elevate social status than in U.S. society. Chinese society places an emphasis on assuming the work of the father; therefore, students are more likely to regard “following a family tradition” as motivation for starting a business.

Second, the top three barriers for starting a business for Taiwan students were “lack of initial capital”, “lack of knowledge of the business world and the market”, and “lack of a high-level of entrepreneurial competence”. The top three barriers for Taiwanese teachers were “lack of initial capital,” “excessive risk,” and “irregular income.” Kendall's Tau analysis shows that Taiwanese teachers and students are highly inconsistent in their rankings of entrepreneurial barriers. The results of the t-test showed that Taiwanese teachers ranked the entrepreneurial barriers “lack of initial” and “excessive risk” significantly higher than students did. Students ranked “lack of experience in management and accounting” higher than teachers did. This has implications for entrepreneurial courses. Teachers must understand student views and focus on resolving the problems and doubts students may experience.

Third, U.S. teachers placed greater emphasis on the barriers of entrepreneurship. They believe that students do not start businesses because numerous entrepreneurial barriers could reduce their freedom and individuality. However, in
Taiwan, the belief in hard work and the higher social status that is associated with being the head of a small company, rather than at the bottom of a large company, motivates students to overcome the difficulties and obstacles of starting a new business. The results indicate that students ranked “lack of knowledge of the business world,” “lack of a high-level entrepreneurial competence,” “lack of experience in management and accounting,” and “lack of ideas regarding what business to start” as crucial barriers. Therefore, universities should provide complete entrepreneurial programs that teach students about business organizations, market analysis, product development, fund raising, and corporate operation before they enter an industry.

We recommended some directions for the future study. First, the researchers can directly collect the opinions of U.S. (or other country) teachers and students to compare with Taiwanese. Second, it can be collected a wide range of teachers’ opinions and not restricted to using only the department chairpersons. Third, it can be collected the opinions of general university students and to compare difference with our study.

We identified four limitations in this study. First, the data were collected by using a questionnaire. Respondents provided opinions about their perceptions of entrepreneurial motivation and barriers. All data were reported by the same group of samples. Therefore, the observed relations may be, in part, a result of the common-method effect. However, this limitation is consistent with the limitations of most survey research.

Second, samples of this research were selected from students of marketing and logistics management departments at technical universities in Taiwan. Therefore, the observed relations may be, in part, a result of the common-method effect. However, the graduates of these departments are likely to start a new business in Taiwan. Therefore, the conclusions are acceptable in this respect.

Third, the opinions of U.S. teachers and students are drawn from the research data of Shinnar et al. (2009). Their study was collected 5 years ago. Perhaps, teachers’ and/or students’ opinions could be changed due to different events occurred during such a long time.

Fourth, Shinnar et al. (2009) surveyed teachers and students at a comprehensive 4-year public university, but the sample of this study was selected teachers and students at technical universities. Perhaps, there will have a little bias for the results.

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REFERENCES


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Facilitating Student Learning From Construction Practice: A Case Study From Denmark And Scotland

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2 School of the Built Environment, Heriot-Watt University, Scotland, UK

ABSTRACT

There is often a claim that there is a disconnection between theory and practice, which raises questions on student’s readiness for employment and the extent that higher education responds effectively to the evolving needs of the construction industry. Industrial placements and mentoring schemes can facilitate student learning from construction practice whereby students can reflect on their learning experience at university. Therefore, this paper examines the different forms of student-industry interaction by reporting on a cross-country comparison of an industrial placement scheme at the Aarhus School of Engineering at Aarhus University and a mentoring scheme at the School of the Built Environment at Heriot-Watt University. An online questionnaire revealed that most students perceived that participation in both schemes helped build their confidence, prepared them for effective engagement with industry, and provided them with a better understanding of their career prospectus. Whilst there is a good practice at both universities, a conceptual framework is also presented which can arguably help in providing an in-depth understanding of the different forms of student/industry interactions in order to facilitate student learning from construction practice. As students become more exposed to industry practice, this would support their readiness to work in the industry and enhance their employability prospectus and performance. Finally, it is contended that student/industry interactions should not be confined to face-to-face interactions in-person, as industry practitioners have constraints on their time, and as such the application of ICT technology, such as Virtual Reality, and innovative schemes such as Constructionarium becomes essential for facilitating further student learning from construction practice.

Keywords: Learning, Practice, Placement, Mentoring

INTRODUCTION

Nowadays the construction professional (such as construction engineer, quantity surveyor, and project manager) deals with an everyday work-life where uncertainty, dynamism and complexity are predominant. Almost every construction professional is challenged daily with incomplete data, conflicting and changing client needs and user demands, communication challenges, pressure from budget and schedule, etc. From an education perspective it is very hard to make students understand and think of solution to such challenges in a traditional classroom setting where it is impossible to theorise everything and to develop closed systems that leaves out disturbing parameters (Mills & Treagust, 2003). Thus, it is clear that if students are to be prepared for the workplace, they need to interact with construction professionals during their studies at university. This rationale is widely recognized (e.g. Bonaccorsi & Piccaluga, 2007; Roberts, Devany, Findlay, Laing, & Buda, 2009) and benefits from doing so is well documented, which can include: increased student employability (Lock, Bullock, Hejmadi, & Gould, 2009; Reddy & Moores, 2006), improved curriculum development (Arlett, Lamb, Dales, Wilis, & Hurdle, 2010; Heesom, Olomolaiye, Felton, Franklin, & Oraifige, 2008; Valentin, 2000; Wandahl, Olsen, & Ussing, 2010), research in terms of innovation and knowledge and technology transfer (Cohen, Nelson, & Walsh, 2002; Perkmann & Walsh, 2009), etc.

It is widely recognized that the link between construction education and practice is paramount as often industry reports highlight students’ skills deficiency and that they are more exposed to theoretical as opposed to practical knowledge. As a third party, the UK government promotes industry-university engagement, as shown in e.g. Lambert (2003) review and the Leitch (2006) review. Similarly, a report from the Danish Ministry of Science, Innovation and Higher Education (FIVU, 2010) promotes the importance of industry-student contact in engineering educations. Universities are now evaluated by students and professional bodies for the effectiveness of their strategy for engagement with industry. The effectiveness of this engagement is important to all stakeholders, mainly construction industry, students, and Higher Education Institutions.

Moreover, construction projects are becoming increasingly complex and the pace of change and innovation of the
construction industry is gaining momentum, albeit innovation in construction is relatively low compared to other industries, as evident by the levels of investment in R&D (Wandahl, Jacobsen, Lassen, Poulsen, & Sørensen, 2011), and this present a challenge for adapting the curriculum of engineering programs. Energy refurbishment of buildings, renewable energy, and waste management are now common topics in many construction-related programmes – which have risen by the industry demand of competencies in these areas (driven by EU government energy policies) and the notion of research-led teaching to incorporate the latest research in the curriculum (see for example: Abdel-Wahab, Ali, & Jenkins, 2013; Abdel-Wahab & Bannadji, 2013).

A schematic framework for university-industry-student interactions is depicted in Figure 1 below (Abdel-Wahab, Wandahl, & Grant, 2013). The focus of this research is on student-industry interaction in HEI's programmes in order to facilitate student learning from construction practice.

Figure 1. Interaction triangle with main objectives for each link. The grey area illustrated the focus of this paper

The Accelerating Change in Built Environment Education (ACBEE) initiative presents a range of case studies to showcase industry and universities collaboration, which includes: curriculum design, students developing a Personal Learning Plan (PLP), students working on real scaled-down projects (constructionarium), Foster-firm scheme (where students spend two weeks of unpaid employment with a company over the summer period) to get exposure to industry experience, industry lectures, etc. Arlett et al. (2010) argue that a tripartite relationship between university staff, students and industry impacts directly on both teaching and curriculum development. This paper goes one step further by arguing that strengthening such an interaction is essential for facilitating student learning from construction practice as well as knowledge exchange, adding contextual knowledge (such as construction projects), increasing employability, and easing transition into the job market for construction students. The university role should be as a facilitator for the engagement between students and industry to support the learning process and knowledge exchange.

The purpose of this paper is to examine the different forms of student-industry interaction by reporting on two case studies at a Danish and a Scottish university. Moreover, the paper presents a conceptual framework for the rationalization of the different forms of student-industry interactions, which could be analyzed in the context of degree programmes. Such framework is a starting point for informing the development of appropriate standards and guidance of student-industry interaction to facilitate optimal student learning which would be relevant for professional bodies and universities as a means of gauging students' performance at the workplace.

**METHODOLOGY**

The approach adopted in this research is an explorative case study in order to identify current practice (existing knowledge) in HEI when it comes to student/industry interaction (Yin, 2003). Malloé (1996) argues that an inductive case study is suitable for creating new understanding, among others because the expected bias is made explicit, and because case study research allows the investigators to retain the holistic and meaningful characteristics of real-life events.

Two explorative cases are applied to gain a thorough understanding of two selected forms of student-industry interaction. The two case studies are for: 1) An Industrial placement scheme at Aarhus University (AU) in Denmark, and 2) The CEMENT (Culture of External Mentoring) scheme at Heriot-Watt University (HWU) in Scotland. Both schemes are for Year 3 undergraduate students undertaking construction-related degree programmes, namely: Civil, Structural and Architectural Engineering at AU; and Quantity surveying and construction project management at HWU. In both cases an online questionnaire (using identical questions) was sent-out to students at both universities to canvass the students' views on both schemes. The questionnaire included questions, which covered the level of satisfaction with the scheme and outcomes of the scheme, such as gaining industry experience, learning about possible career paths, and building confidence. The questionnaire was based on mainly open-ended questions and 5-point Likert-scale questions. At AU, there were 154 student participants in the industrial placement scheme and 71 respondents to the questionnaire resulting in response rate of 46 %. At HWU, there were 40 student participants in the mentoring scheme and 15 respondents to the questionnaire resulting in a response rate of 38 %. Different surveys within the construction industry have typically a response rates between 20 % and 55 % (Albert, Daniel, & Kathy, 2003; Bröchner, Josephson, & Alte,
The response rate in this survey at 38% is acceptable and above average for socio-technical research in general (Futrell, 1994). Response rate is considered acceptable and sufficient for ensuring validity. A possible explanation for not having a higher response rates is that participation was on voluntary basis. The results from the questionnaires are used as the basis of the cross-country comparison of both schemes in terms of scheme objectives, perceived outcome, etc. The idea is to provide a comparative analysis of these different forms of student-industry interaction with a view of sharing good practice and identifying potential areas of further development.

**STUDENT-INDUSTRY INTERACTION**

Student-industry interaction is essential for providing students with industrial experience and it can provide students with an opportunity for linking ‘what they study at university’ and construction practice thereby enhancing their learning experience. Experiential Learning Theory (ELT) emphasizes the central role that experience plays in the learning process whereby knowledge results from the combination and transformation of experience (Kolb, Boyatzis, & Mainemelis, 2000). ELT involves grasping experience through ‘Concrete Experience’ (CE) and ‘Abstract Conceptualisation’ (AC) and modes of transforming experience through ‘Reflective Observation’ (RO) and ‘Active Experimentation’ (AE) which forms the Kolb cycle (Kolb et al., 2000) as illustrated in Figure 2 below.

![Kolb learning cycle](image)

**Figure 2. Kolb learning cycle**

Students can grasp CE through interaction with industry, which can include: guest lectures, site visits, networking events, job shadowing, industrial placements, etc. If students are then to follow the Kolb cycle (AC → RO → AE) it can provide useful framework for facilitating their learning and personal development. A further discussion of the Kolb cycle is beyond the scope of this paper but suffice to mention that the provision of CE for students can facilitate and trigger student learning from experience. For example, given that many young students lack sufficient experience to imagine what kind of work they might do as professionals (ASME, 2011), and what career path they might embark on, then Concrete Experience can provide them with insights of what job they will do when they complete their course as well as their potential career path.

Students could be regarded at the receiving end (in terms of building-up their knowledge and experience), but as they progress with their studying they build-up their knowledge and experience through proactive engagement with industry. Final year students, typically, carry-out a research project (dissertation) which may provide a contribution towards enhancing the industry’s knowledge base by focusing on the industry’s topical issues. For example, exploring the impact of Building Information Modelling (BIM) on the practice of Quantity Surveyors and investigating the industry’s awareness of the New Rules of Measurement (NRM) published by the Royal Institution of Chartered Surveyors (RICS) and to what extent they have been applied by industry. In fact these topics were undertaken by students who were supervised by one of the authors at Heriot-Watt University. The external examiners commended the quality of dissertations as being topical and relevant to the current issues and challenges facing the construction industry. This evidences that the dyadic relation in the interaction model has proven to be two-directional. Learning and knowledge flows in both directions for the benefit of the student, the industry and the Higher Education Institution.

**Industrial Placement and Mentoring Schemes**

Industrial placements can be embedded or formalized in degree programmes, which are then referred to as “sandwich courses” which have been popular in the UK. A “sandwich course” is a term given to work placement during university degree course where the work placement is usually “sandwiched” between the second and third year of a degree (if the placement last for a full academic year it is referred to as “thick sandwich” and if it lasted 3-6 months, it is referred to as “thin sandwich” (E4E, 2011). In Denmark, Bachelor of Engineering’ courses mandate that students go on a 6-months placement which can be regarded as a “thin sandwich” course in the UK.

Benefits of sandwich courses to students can include: enhanced employment prospects, improved skills, the opportunity to experience the working environment in the chosen subject area and improved academic grades, etc.
(Little & Harvey, 2006). Moreover, sandwich courses (in science and engineering) in the UK are regarded by professionals and academics as having a significant positive effect on students’ personal development (E4E, 2011). A study conducted in 2004 found that participation in industrial placement schemes significantly enhanced the likelihood of students’ attaining first class or upper second class honours degrees (Mandilaras, 2004).

The industrial placement scheme at AU is mandatory and it constitutes one full semester, equal to 30 ECTS’ over 6 month (Dahlgren, Fejes, Dahlgren, & Trowlad, 2009) which could be regarded as a ‘thin sandwich’ course. On average 150-200 students pass through the scheme yearly. The main learning objectives are to demonstrate how knowledge can be applied in practice to address engineering problems. Students are responsible for signing a contract with a relevant industrial company, but the University has a full time coordinator who facilitates the process. A few students per year do not manage to arrange an industrial placement and they are allowed to continue with the next semester and then thereafter (a half year later) re-entering the industrial placement scheme. Payment is optional for the company, but 80-90 % of the students obtain a salary, averaging £1250 per month.

Mentoring schemes are a less formalized form of student-industry interaction (when compared to industrial placements on “sandwich courses”) as it is not embedded within their curriculum of study and there is no formal assessment. Students can choose either to opt-out or participate in the scheme and usually there are no overly prescriptive requirements with mentoring schemes as opposed to industrial placement opportunities (“sandwich courses”). The aim of the CEMENT scheme is to strengthen the links between construction management and surveying (CMS) undergraduate students and built environment professional practice by inviting previous CMS alumni; to mentor current students, providing support and contributing to their discipline knowledge development. In addition this helped to maintain the programmes position at the forefront of CMS provision and strengthened the awareness of the quality of our graduates, increasing their profile in the built environment profession, ultimately resulting in increased employment opportunities.

Existing literature predominantly focuses on the evaluation of student-industry interaction with a specific focus on reporting the benefits. For example, Chamber, Holm, and Worzala (2009) found that programmes which provide students with strong industry interaction are ranked higher amongst students most notably for the provision of informal networking opportunities; in addition Mandilaras (2004) found that student performance has improved as a result of participation in placement; and finally Little and Harvey (2006) reported that students had better employment prospects and acquired better skills by going on placements. This paper contributes to the existing literature by providing an evaluation of two forms of student-industry interaction, namely industrial placement scheme at Aarhus School of Engineering at Aarhus University in Denmark and mentoring scheme at the School of Built Environment at Heriot-Watt University. The evaluation is not only confined to assessing the benefits of each individual scheme but also it provides a cross-country comparative analysis with a view of providing an in-depth understanding of student-industry interaction for facilitating students learning at universities.

**FINDINGS AND DISCUSSION**

Given that industrial placement scheme (AU) is a mandatory scheme whereas the mentoring scheme (HWU) is an elective, it is thus relevant to investigate the students’ initial expectations before participating in the scheme. In both schemes students rate “to get industry insight” high, 38 % in HWU and 25 % in AU which is unsurprising as the main learning objective in both schemes is exactly that. This rationale has also been validated through several reporting on benefits from student-industry interaction (e.g. Bonaccorsi & Piccaluga, 2007; Roberts et al., 2009). Some differences between student expectations towards the two different modes stand out. “Not sure” and “Low or no expectation” adds up to 46 % of all respondents for the HWU scheme. This is a remarkable high percentage. In the AU scheme “To obtain hands on experience” and “To have responsibility for real tasks” equals 40 %. Thus it can be inferred that there is a difference in initial expectation which will be dependent on the form of interaction (See Figure 3 above). In mentoring scheme students do not necessarily get hands on experience and have no responsibility for actual tasks in a construction company. In order to address the students uncertainty about what to expect from a mentoring scheme, there is a need to showcase examples of past student experiences. At the AU scheme prospective students have access to past industrial placement evaluation reports. In the HWU scheme, students are required to produce a poster to showcase their experience.

When respondents were asked to list key activities performed during the scheme, the difference in the core nature of the two schemes become apparent. It could be argued that given the nature of the AU industrial placement scheme being mandatory and paid placement, then employers try to maximise the return of investment by getting students to participate in actual work activity. For the CEMENT scheme, a ranked list of key activities included: 1) Site visits (36 %), 2) Guidance on career paths (29 %), and 3) Just meeting mentor (21 %). For the AU scheme the ranked list included: 1) Quality management (41 %), 2) Construction design, calculation and statistics (38 %), and 3) Planning and management (34 %). The degree of interaction can be also validated by how often the student interacts with their industrial contact person (mentor or industrial supervisor). In the industrial placement scheme at AU, 72 % interacted or engaged with their industrial contact person at least once per week, whereas in the mentorship scheme only 7 %

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1 European Credit Transfer System. 30 ECTS is equivalent to a full semester.
interacted once per week or more, cf. table 1. Thus, it can be inferred that a significant difference in degree of interaction or engagement between industrial placement and mentorship is observed. Finally, it should be noticed that the AU industrial scheme is integrated in curriculum, and the HWU mentor scheme is not. Both schemes are placed in the third year of study, which indicates that a certain amount of engineering knowledge is needed by the students to have success participating in such student-industry schemes.

While initial expectation and degree of interaction are relevant parameters, the actual learning outcome is even more important. Table 1 show some of the key data from the two surveys for this parameter.

Table 1: Learning outcome from each of the two schemes.

<table>
<thead>
<tr>
<th>Participation in the scheme has helped build my confidence</th>
<th>HWU [%]</th>
<th>AU [%]</th>
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<tbody>
<tr>
<td>5: Strongly agree</td>
<td>57 %</td>
<td>43 %</td>
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<tr>
<td>4: Agree</td>
<td>29 %</td>
<td>41 %</td>
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<td>3: Neutral</td>
<td>7 %</td>
<td>10 %</td>
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<td>2: Disagree</td>
<td>0 %</td>
<td>4 %</td>
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<tr>
<td>1: Strongly disagree</td>
<td>7 %</td>
<td>1 %</td>
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<tr>
<th>Studying at university has prepared me for effective engagement with industry</th>
<th>HWU [%]</th>
<th>AU [%]</th>
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<tr>
<td>5: Strongly agree</td>
<td>20 %</td>
<td>83 %</td>
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<tr>
<td>4: Agree</td>
<td>50 %</td>
<td>14 %</td>
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<td>3: Neutral</td>
<td>30 %</td>
<td>3 %</td>
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<tr>
<td>2: Disagree</td>
<td>0 %</td>
<td>0 %</td>
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<tr>
<td>1: Strongly disagree</td>
<td>0 %</td>
<td>0 %</td>
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<table>
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<tr>
<th>Interaction with industry has helped me to understand my career path</th>
<th>HWU [%]</th>
<th>AU [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>5: Strongly agree</td>
<td>43 %</td>
<td>49 %</td>
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<tr>
<td>4: Agree</td>
<td>36 %</td>
<td>42 %</td>
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<tr>
<td>3: Neutral</td>
<td>0 %</td>
<td>6 %</td>
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<tr>
<td>2: Disagree</td>
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<tr>
<td>1: Strongly disagree</td>
<td>14 %</td>
<td>0 %</td>
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</table>

There is a significant difference between a classic classroom-learning situation and a real work situation on-site or in an engineering office. Most students recognise this bias, which makes them unsure about their performance and capabilities after graduation.

The context of construction work is very complex, dynamic, and challenging in many aspects. The purpose of student interaction with industry is to provide an opportunity for experiential learning, prepare student for their future work life, and help in building their confidence. Table 1 illustrates that both the AU and the HWU scheme can help increasing student’s confidence significantly. Above 80 % agree and strongly agree that participation in the scheme has helped build their confidence. In both schemes it is evident that students are satisfied with skills and knowledge learned in class, because 70 % at HWU and 97 % at AU agree or strongly agree that studying at university has prepared them for effective engagement with the construction industry.

Students also agree that the industry interaction has helped them understand their potential career path in the industry. It should though be noted that 21 % of the HWU student disagree or strongly disagree. This is a remarkable high percentage, but the reason for the low score is to be found in the mentor being very busy, mentors who have misinterpreted the mentor role and personal mentor-mentee issues. Both Armstrong, Allinson, and Hayes (2002) Cox (2007) puts forward the challenges of forced coupling between mentor and mentee in formalised mentoring schemes. The mentor should be a role model for the mentee. Role modelling involves the mentor in setting a desirable example and the mentee identifying with it, in both a conscious and an unconscious process. “Where there is compatibility between mentor and protégé there is the potential for substantial and often rapid professional growth. Where there are disparities in personal outlook or professional principles, then the benefits may be limited.” (Bush, Coleman, Watt, & West-Burnam, 1996, p. 122, p. 122)

The findings of the HWU scheme are consistent with (Grant, 2011) who argued that the rewards of the scheme can include: increased site visit opportunities and summer work placement offerings are two advantages that will provide students with additional experience with on-site construction activities, and increased students’ contextual knowledge. Even though mentoring only constitutes one third of the interaction triangle, cf. figure 1, it also facilitates improved linkage between industry and university.

Grant (2011) argues that a higher profile of Construction Management and Surveying students in the built environment profession as well as industry involvement in curriculum design were some of the benefits of a successful mentoring scheme. In total all parties in the interaction triangle provide positive feedback to the scheme.

The aforementioned discussion demonstrates that there is an existing good practice for student-industry interaction through both the AU and HWU schemes. The results of the survey are satisfactory although they rely on the perception of the participants in the scheme (qualitative data) as opposed to quantitative data. However, this is a starting point for
the evaluation of the efficacy of the different forms of student-industry interaction. It has to be noted that this paper focused only on two forms of student-industry interactions at two European Universities where the authors work, namely: Industrial placement (AU in Denmark) and mentoring (HWU in Scotland) – as shown in Figure 3.

The different forms of student-industry interaction (site visits, guest speakers, project collaboration with industry, etc) can be represented using a schematic diagram (see Figure 3) based on the ‘degree of interaction’ and ‘length of interaction’.

**Figure 3.** Form and duration of student-industry interaction – a schematic diagram

The ‘duration of interaction’ (x-axis) can be arbitrarily defined by the number of hours students experience with industry, e.g. a guest lecture could be 1, 2, 3,...hrs. and a placement could be 3, 6,...months. The x-axis is not a numerical scale, more a continuum with zero time at one end and more time use at the other. The ‘Form of interaction’ (y-axis) can be defined by the level of first hand-experience exposure to industry environment or practices. In first hand-experience students observe with their own eyes and doing it themselves in a controlled environment whereas second-hand experience is when someone is telling them about it through a lecture or a video, interview, etc. As the length and degree of student-industry interaction can take different forms, it can be regarded as generally progressive but it could vary depending on the type of academic programme requirements which could be shaped by legislation and professional bodies’ requirements in each country.

**Thinking Beyond Conventional Student-Industry Interaction**

Any form of industry participation to support student learning in the form of placement or mentoring schemes, requires industry practitioners to voluntarily give-up time of their busy schedules. As such, there is a need to capitalize on alternative methods using technology and innovation in order to provide students with other opportunities for interaction with industry, e.g. using simulation and virtual environments – below are few examples in that respect.

The use of technology and innovation for providing a simulated industry interaction can thus provide a plausible means for student-industry interaction, e.g. Advanced Construction Technology Simulation Centre (ACT-UK) at Coventry University in the UK. The centre is a dedicated simulation training centre for professional occupations, such as project managers, and potentially students (ACT-UK, 2012). Students can be immersed in simulated construction site environments, so that they can experience construction projects and be exposed in a safe environment to practical situations, such as: work planning and coordination and conflict resolution scenarios (Ku & Mahabaleshwar, 2011; Li, Chan, & Skitmore, 2012). The main benefit is to enable trainees and students to cross the boundary between learning about a subject and learning by doing it and integrating these together so that the development of construction management skills can be enhanced and even accelerated (Stothers, 2007).

Another form of work simulation where students can interact with industry is Constructionarium. Constructionarium is a collaborative framework where university, contractor and consultant work together to enable students to physically construct scaled-down versions of built assets, such as buildings and bridges. This enables students to enhance their knowledge of construction processes and associated challenges that cannot be developed fully solely through traditional classroom learning (Ahearn, Wise, McCann, & Goring, 2005). Constructionarium is held as a 6 day working field course. The participants construct scaled down versions of bridges, buildings, dams and civil engineering projects. Students are assessed on the final day in terms of budgetary control, methodology and timely completion. For example, the Gherkin landmark 180m tall 40 storey office building is in the heart of London’s financial area. The students will build a three storey, 12m tall version using pre-fabricated steel elements and tie in on site precast
floor elements. In the US Auburn University developed a field laboratory where construction engineering student can build small full scale models of construction elements, and thereby obtain hands on experience (Burt, 2012). The field lab is equipped similar to a real construction site, but the activity taking place on site is only for learning purpose. This concept is fairly similar to what is applied when learning craftsman skills in vocational training.

University of New South Wales in Sydney, Australia, has also developed a simulation computer game in first person shooter mode, called a Situation Engine. Based on Newton, Lowe, and Zou (2010) a Situation Engine is an application that provides for specific and managed practical experience to be made available to students through advanced digital technologies. The concept of an ‘engine’ is one where the same system is capable of being used to drive a variety of different ‘situations’ in a variety of ways. A ‘situation’ in this context is proposed as an alternative conception to ‘problems’ and ‘projects’ as the basic pedagogical framework for learning. The intention is to recognize and promote a focus on the experiential aspects of an exercise. This enables student to experience the complexity of a construction site and its environment in a virtual reality.

CONCLUSION

Student-industry interaction can enhance graduate skills levels and ensure a smooth and effective transition between university and business environment, and as such there is a need to increase opportunities for students to acquire relevant work experience during their studies (Wilson, 2012), which was corroborated by the findings presented in this paper. Moreover, the paper has presented a conceptual framework for understanding the different forms of student-industry interaction whereby supporting students’ readiness for employment – as shown in Figure 3 above – nonetheless it requires further research for validation. The ultimate aim is to address the question as to ‘how higher education provision, where industrial experience is embedded, can support student employability and performance at the workplace? Addressing this question becomes crucial given that a recent CIOB report entitled “No More Lost Generation” found that graduates have inadequate employability skills and employers were not satisfied with the standards of graduates (CIOB, 2014). It follows that there is a need for further research to provide guidance on the most appropriate forms and duration of student-industry interaction over the course of study at university to ensure that graduates have the required employability skills and even attain high performance levels at their workplace. Finally, the industry should recognized their role in facilitating student learning from practice by always providing access to placement opportunities, and not simply be there in the good times.

REFERENCES


Cohen, W. M., Nelson, R. R., & Walsh, J. P. (2002). Links and impacts: the influence of public research on industrial engineering education provision, where industrial experience is embedded, can support student employability and performance at the workplace? Addressing this question becomes crucial given that a recent CIOB report entitled “No More Lost Generation” found that graduates have inadequate employability skills and employers were not satisfied with the standards of graduates (CIOB, 2014). It follows that there is a need for further research to provide guidance on the most appropriate forms and duration of student-industry interaction over the course of study at university to ensure that graduates have the required employability skills and even attain high performance levels at their workplace. Finally, the industry should recognized their role in facilitating student learning from practice by always providing access to placement opportunities, and not simply be there in the good times.
Assessment Criteria of Vocational College Students’ Learning Engagement

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3 Associated Prof., Department of Hospitality Management, Hungkuang University, Taiwan

ABSTRACT

Teaching effectiveness has always been the most effective index to evaluate inter-quality of teaching and education. However, multiple factors are possibly affecting teaching outcomes; no conclusions have been made toward its assessments criteria. The decision-making trial and evaluation laboratory (DEMATEL), widely used in social science, was employed in this study to testify the significance of certain assessment criteria, and to clarify the complexity of each criterion, stratified random sampling was used to collect 158 questionnaires from seven vocational colleges in the north, central and south Taiwan, and the correlation among the assessment criteria of the students’ learning engagement was investigated using DEMATEL. Cognitive learning engagement criteria and student-oriented education perspective were suggested in achieving teaching effectiveness.

Keywords: Teaching effectiveness, Assessment criteria, Decision-making trial and evaluation laboratory (DEMATEL)

INTRODUCTION

Teaching effectiveness has been a critical issue in recent studies (Dobbie, 2011; MetLife Foundation Issue Brief, 2008; Schuetz, 2008; Zyngier, 2011). Dobbie (2011) predicted students’ learning performances by variables related to teacher’s professional. Wallace, Sung and Williams (2014) investigated teachers’ personal characteristics impact on students’ learning performances. One thing in common was that teacher was the only subject in the previous studies. As different paradigms underwent, researchers may agree on how learning engagement possibly affects teaching effectiveness (Angell, 2009; Dobbie, 2011; Swann, 2013), yet diverse opinions have been observed on the dimensions and their correlation of learning engagement (Bryson and Hand, 2007), the definition (Krause and Coates, 2008), and whether the students’ perspectives should be applied to study conclusions (Bryson and Hand, 2007; Kuh, 2009; McGarrigle, 2013). The learning performance analysis can be processed under both student and teacher oriented perspective. However the protocol establishment still has a long way to go.

Several factors might have engaged with the students’ learning performances. A highlighted growing trend of engagement theory has pointed out that the learning process, emotional motivation, and self expectation might influence teaching effectiveness (Wallace, Sung & Williams, 2014). The framework, methodology and suggestions of the engagement theory provided practical contribution. For example, Kuh (2009) adopted students as the main research objective of learning performances, and these transforms are widely accepted by most scholars due to its comprehensive effects on the teaching system and the general and concrete description of factors regarding students’ learning performances (Angell, 2009; Dobbie, 2011; Swann, 2013).

Previous teaching effectiveness studies were mostly conducted for teaching or administrative purposes, such as improving a teacher’s teaching techniques and the application of assistive technology. These results could have improved teaching effectiveness, but were less likely to adopt proper indicators for student-oriented requirements (Kuh, 2009). Most scholars have defined learning engagement as a student’s behavior and reflection toward the learning process that directly affect teaching effectiveness (Krause and Coates, 2008 : Kuh, 2009). In other words, learning engagement also includes the time and energy that students spend on educational activities, and these activities will produce a positive impact on students through their interaction with others. Participation in school activities, engagement with specific educational activities, and cognitive strategies were mentioned in recent researches (Angell, 2009), showing that there is wide and complex coverage on the indicators of student learning engagement. Although learning engagement theory creates a better picture of a teaching model, insufficient research has been carried out on the correlation among engagement related factors. To fully understand teaching effectiveness, it is important to first establish the correlation data as a firm basis for the assessment criteria.

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The aim of this study is to discover the factors that influence vocational students’ learning engagements and the correlations between them. A student-oriented study was conducted to gather and analyze students’ behavior and reflections toward the learning process together with those criteria that were within emotional and cognitive dimensions in order to provide a comprehensive reference for further evidence-based applications. The conclusion of this study also explores the clear correlation and interaction among the learning engagement criteria so as to control the critical indicators, improve higher education learning effectiveness over time and avoid the wastage of resources. This study included a literature review, a study design, analytical discussion, conclusion and application to utilize the findings and the contributions made by previous researches.

**LITERATURE REVIEW**

**Related Literature on Student Engagement**

Appleton, Christenson, and Furlong (2008) pointed out that an accredited learning process should consist of individual learning backgrounds, learning records, and engagement that can clearly manifest the reasons and impacts before and after learning engagement and its final outcome. Fullan (2014) suggested reasons that may affect student learning engagement and output, including real time perception and satisfaction with academic performance and learning engagement. They concluded that hard work is the key to success instead of ability or other external factors, valuing educational achievement and being an educated civilian as a goal or the key to approach goals, and peer impact, especially the identity from peers of one’s highly involvement. The same argument was observed in other studies. For instance, Greene, Marti and McClenny (2008) suggested that a school is obligated to create a more supportive system. In addition, learning engagement will not be enhanced if the education budget does not relate to an aspect of the student’s learning (McGarrigle, 2013). Meanwhile, test scores, self learning evaluations, and learning persistency have a positive correlation with learning engagement (Wang, 2011). Except for participation frequency, learning engagement also covers a student’s learning strategy and attitude. Thiessen and Blasius (2008) found that students with better learning strategies usually performed better, which showed a direct correlation with learning strategies and their effectiveness. Previous studies mentioned that students perform better in subjects they have an interest in, suggesting there is a correlation between learning interests and learning achievement (Swann, 2013). The willingness to learn could be enhanced when their interest and motivation are raised, with the result being enhanced effectiveness. In summary, learning engagement and learning achievement are closely connected and share a positive correlation.

Yazzie-Mintz (2010) have been reviewed in order to develop measurable indicators for learning engagement and have been divided into the three categories of behavior, emotion, and cognition. DEMATEL was employed to discover the key factors that affect vocational students’ learning performances, and to testify the significance of the assessment criteria and the relationship among them.

To summarize the relevant results, this study designated learning engagement into the categories of behavioral, emotional, and cognitive; each category has four criteria, as in Table 1.

<table>
<thead>
<tr>
<th>Category</th>
<th>Criteria</th>
<th>References</th>
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<tbody>
<tr>
<td></td>
<td>A2. attending classes on time</td>
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<td>B4. challenging course context</td>
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<td>Cognitive learning engagement</td>
<td>C1. learning strategy</td>
<td>Blasius(2008); Thiessen &amp; Swann (2013); Walker &amp; Greene (2009); Yazzie-Mintz (2010)</td>
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<td>C2. improved self-expertise</td>
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**Source:** The Research

**RESEARCH DESIGN**

**Decision making trial and evaluation laboratory (DEMATEL)**

Previous social science studies had not considered the assessment criteria correlations (Wang, 2011; Wang and Tseng, 2014). The decision making trial and evaluation laboratory (DEMATEL) is well known for analyzing factor correlations and causal relationships in the social sciences (Wang, 2011). This was first used in 1971 at the Battelle Institute, in Geneva to discuss the solutions and correlations between humans and technology, such as famine, racism,
human rights, epidemic issues and violence. Different from the thinking behind systems thinking, DEMATEL is able to investigate the direct and indirect relationships of complex issues using quantitative methodology (Wang and Tseng, 2014).

DEMATEL was applied in this study to detect the direct and indirect correlations among factors that are related to vocational students’ learning engagement, the critical indicators were suggested to provide a reference for learning engagement and effectiveness (Wang and Lin, 2014).

Development of the Questionnaire

A pretest was performed before the DEMATEL was carried out. 150 pretest data were distributed to junior (3rd grade) students of a private vocational college in central Taiwan. 126 returns were counted as valid. The Cronbach $\alpha$ for behavioral learning engagement was 0.787, the Cronbach $\alpha$ for emotional learning engagement was 0.799, and the Cronbach $\alpha$ of cognitive learning engagement was 0.773. The Cronbach $\alpha$ of the three categories were greater than 0.7, showing reliable internal consistency of the questionnaire (DeVon et al. 2007).

Validity had been tested via literature review to assure integrity and importance of the variance. The pretest results explained that the variance of behavioral learning engagement was 53.38%; the explained variance of emotional learning engagement was 57.08%, and of cognitive learning engagement was 54.26%. The explained variance of the questionnaire was 61.23%. Each category received qualified explained variance (Iacobucci and Duhachek, 2003).

Research Tool

The questionnaire for developing DEMATEL was applied in the study. The intention was to discover the direct and indirect relationships of the learning engagement indicators and the DEMATEL was then used to reveal the correlations. The questionnaire was composed of student’s learning engagement indicators after literature review. Both freshmen and sophomores were recruited from vocational colleges in northern, central and southern Taiwan as our questionnaire respondents. This assumed that all the respondents precisely knew of the correlation among the assessment criteria so as to secure the validity of the information (DeVon et al. 2007). The definitions of the criteria were explained first, and then each criterion was compared from 0 to 3. 0 suggests no effect, 1 suggests a slight affect, 2 suggest an effect of some kind, 3 suggests a strong effect. Table 2 shows the questionnaire form.

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<tr>
<td>C4. problem solving skills</td>
<td></td>
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<td></td>
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</table>

Research Respondents

Freshmen and sophomores were recruited from vocational colleges in northern, central and southern Taiwan as the questionnaire respondents. There were 90, 60, 60 questionnaires assigned in the three demographic region respectively, according to the 3: 2: 2 stratified random sampling. 210 questionnaires were distributed in total and 158 were returned as valid samples; the overall response rate was 75.24%, as in Table 3.

<table>
<thead>
<tr>
<th>Items</th>
<th>Sampling No.</th>
<th>Gender</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
<td>Freshmen</td>
</tr>
<tr>
<td>Northern area</td>
<td>90</td>
<td>49</td>
<td>48</td>
</tr>
<tr>
<td>Central area</td>
<td>60</td>
<td>32</td>
<td>28</td>
</tr>
<tr>
<td>Southern area</td>
<td>60</td>
<td>30</td>
<td>28</td>
</tr>
<tr>
<td>Total</td>
<td>210</td>
<td>111</td>
<td>101</td>
</tr>
</tbody>
</table>

ANOVA (Analysis Of Variation) was performed to ascertain the perceptive difference between the students from
different demographic region. No significant difference was found with regards to the perception of the study questionnaire ($p = .389 > .050$, as in Table 4).

Table 4. ANOVA of demographic region of respondent’s

<table>
<thead>
<tr>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Group</td>
<td>12.838</td>
<td>2</td>
<td>6.419</td>
<td>3.065</td>
</tr>
<tr>
<td>Within Groups</td>
<td>299.465</td>
<td>143</td>
<td>2.094</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>311.415</td>
<td>145</td>
<td>2.862</td>
<td></td>
</tr>
</tbody>
</table>

**Implementations**

The data were collected from the freshmen and sophomores of vocational colleges in northern, central and southern Taiwan. Direct and indirect correlations were then calculated separately to design the causal diagram. The DEMATEL was then processed as following:

1. Step 1: Develop a pairwise direct-relation matrix between the system components through decision maker input.
2. Step 2: Determine the initial influence matrix by normalizing the direct-relation matrix.
3. Step 3: Calculate the total relation (direct/indirect matrix) matrix.

To illustrate the causal diagram, calculate the direct/indirect matrix and locate $D + R \cdot D - R$ for the causal diagram. The sum of the rows and the sum of the columns are separately denoted as $D$ and $R$ within the total-relation matrix $T$ through the formulas (1) and (2):

$$D_i = \sum_{j=1}^{n} t_{ij} \quad (i = 1, 2, \ldots, n)$$

$$R_j = \sum_{i=1}^{n} t_{ij} \quad (j = 1, 2, \ldots, n)$$

**RESULTS AND DISCUSSIONS**

This study added up the totals of $x$ and $y$, and $D + R$ prominence indicated the importance of the criteria in the assessment. Those $D + R$ prominences which were greater than the average 13.631 were then chosen, of which the criteria played a relatively critical role in vocational college students’ learning engagement. There were five qualified criteria and these were listed according to the degree of importance: C3. Sense of achievement; C2. Improve self-expertise; C4. Problem-solving skills; A4. Previews, assignments and reviews; and C1. Learning strategy (Table 5 for detail).

Table 5. Correlation of vocational college students’ learning engagement criteria

<table>
<thead>
<tr>
<th>Sum of Row(D)</th>
<th>Sum of Column(R)</th>
<th>$D + R$</th>
<th>$D - R$</th>
</tr>
</thead>
<tbody>
<tr>
<td>item</td>
<td>value</td>
<td>item</td>
<td>value</td>
</tr>
<tr>
<td>B4</td>
<td>9.316</td>
<td>C4</td>
<td>7.524</td>
</tr>
<tr>
<td>C3</td>
<td>8.381</td>
<td>C2</td>
<td>7.454</td>
</tr>
<tr>
<td>B2</td>
<td>7.462</td>
<td>A2</td>
<td>6.650</td>
</tr>
<tr>
<td>C1</td>
<td>7.355</td>
<td>A3</td>
<td>6.624</td>
</tr>
<tr>
<td>B3</td>
<td>7.006</td>
<td>A4</td>
<td>6.568</td>
</tr>
<tr>
<td>C2</td>
<td>6.833</td>
<td>C1</td>
<td>6.530</td>
</tr>
<tr>
<td>B1</td>
<td>6.346</td>
<td>B1</td>
<td>6.452</td>
</tr>
<tr>
<td>C4</td>
<td>6.073</td>
<td>B3</td>
<td>6.196</td>
</tr>
<tr>
<td>A2</td>
<td>5.902</td>
<td>B2</td>
<td>6.051</td>
</tr>
<tr>
<td>A3</td>
<td>5.497</td>
<td>A1</td>
<td>6.016</td>
</tr>
<tr>
<td>A1</td>
<td>5.146</td>
<td>B4</td>
<td>5.897</td>
</tr>
</tbody>
</table>

Remark: * greater than the average value (13.631)

The results suggested that vocational college students’ learning engagements were focused on C3. Sense of achievement; C2. Improve self-expertise; C4. Problem solving skills; A4. Previews, assignments and reviews; and C1.
Learning strategy. Four out of these five criteria belong to the cognitive category, which is inconsistent with the self-determination theory from Schuetz (2008). This was based on autonomy, competence and relationships formed by motivational needs. The self-determination theory seems to fall short on learning engagement.

**Relation (D - R)**

The D - R (relation) value was approached in that the row sum minus the column sum was taken as the determinant. The criterion has a direct impact on other criteria when the positive D - R is greater, which means the criterion is critical for the student’s learning engagement. A higher point criterion represented that it helped vocational college students engage in the learning programs. In contrast, the negative D - R is less important, and only has a limited impact on student’s learning engagement. According to the D - R values, the top three important criteria that directly affect other criteria were ascertained: B4. Challenging course context; B2. Interesting teaching material; and A4. Previews, assignments and reviews. Additionally, C4. Problem solving skills and C2. Improve self-expertise should be set as the fundamental factors of learning engagement as they were recognizable and easily affected by other criteria (Table 5 for detail).

**Prominence (D + R)**

The assessment criteria showed there was a greater impact on the vocational college students’ learning engagement process when the D+R (prominence) is higher. Five chosen criteria with D+R values greater than the average of 13.631 were all categorized for the category of behavioral and cognitive learning engagement. Therefore, the following four criteria in the cognitive category were suggested to detect vocational college students’ learning engagement qualifications. Moreover, the following five criteria, C3. Sense of achievement, C2. Improve self-expertise, C4. Problem solving skills, A4. Previews, assignments and reviews and C1. Learning strategy were suggested methods to facilitate students’ learning engagement that could be applied during course planning. This study illustrated the causal diagram for the Assessment Criteria of Vocational College Student’s Learning Engagement in order to visualize the correlations among each criterion and the impact on student’s learning engagement (Figure 1).

![Causal Diagram of Learning Engagement](image)

**Figure 1. Causal Diagram of Assessment Criteria of Vocational College Student’s Learning Engagement**

Figure 1 consists of four dimensions. The positive D - R value was located in dimensions I and II, with the D+R values in these two dimensions above the average of 13.631 and located on the right side of the y axis. A4. Previews, assignments and reviews, and C1. Learning strategy were located in dimension I, which meant the criteria played a relatively critical role in learning engagement. Therefore, A4 and C1 could be applied as key indicators for teachers examining the learning engagement qualification of students. C3. Sense of achievement; C2. Improve self-expertise; and C4. Problem solving skills were also critical for learning engagement. Due to the characteristic of criteria in dimension II were likely to be affected, when using these criteria for the student-oriented perspective, the requisition was that students were asked to feature with cognitive learning engagement, and that teaching effectiveness could be achieved with a combination of emotional learning engagement (B4, B2, B3, and B1).

This study revealed that the top three influential assessment criteria for the vocational college students’ learning
engagement were C3. Sense of achievement, C2. Improve self-expertise, C4. Problem solving skills. In summary, it is suggested that cognitive criteria, which represents the student-oriented perspective, have better outcomes in learning engagement, showing significant differences with the results from Umbach and Wawrzynski’s teacher-oriented learning engagement study (Umbach and Wawrzynski, 2005). The study questionnaire for this research was designed from a student-oriented perspective and the results could only be interpreted under this perspective (Bryson and Hand, 2007; Richardson, 2013; Stephen and Goldberg, 2013).

This study also explores how the different theoretical foundation of learning engagement could cause a diverse study conclusion. The biggest delay between the outcomes of learning engagement in the student-oriented and teacher-oriented perspective is that with the latter learning engagement, teachers must utilize emotional learning engagement and teaching behavior so as to form a proper teaching environment to guide the learning engagement of the students. On the other hand, student-oriented learning engagement emphasizes self engagement from a cognitive aspect. A4. Previews, assignments and reviews, and C1. Learning strategy were considered to be useful criteria when examining a student’s learning engagement. C3. Sense of achievement, C2. Improve self-expertise, and C4. Problem solving skills should be viewed as self cognition of a student’s learning engagement, if it is a student-oriented approach to enhance students’ learning motivation (Kirschner and van Merriënboer, 2013).

CONCLUSIONS AND IMPLICATIONS

Some arguments were reviewed in this study, including intrinsic and extrinsic motivations, teacher-oriented or student-oriented perspective learning engagement outcomes, and it was found that all could possibly be influential to a students’ learning engagement. Balancing teaching effectiveness and the right to education, the assessment criteria can be applied in order to realize direct and indirect correlations; the study results were divided into conclusions, management applications, and limitations and suggestions in the following paragraphs:

Conclusions

In summary, this study revealed that the influential assessment criteria of vocational college students’ learning engagement were C3. Sense of achievement, C2. Improve self-expertise, and C4. Problem solving skills. Among the three cognitive learning engagement criteria, C3. Sense of achievement was the main influential assessment criteria. C2. Improve self-expertise, and C4. Problem solving skills should be viewed as fundamental factors. That is, from a student-oriented perspective, courses can be designed to enhance students’ problem solving and professional skills, and the content and teaching arrangement should be modified according to individual levels. These will help students to attain a sense of accomplishment.

A4. Previews, assignments and reviews, and C1. Learning strategy were considered to be useful criteria for examining students’ learning engagement. Teachers should encourage students to establish a study plan as soon as possible. Previews, assignments and review work could be practiced and formed into a habit for teaching. When the cognitive learning engagement aspect is ready, by handing in an assignment and a quiz, teachers might be able to trace a student’s behavioral learning engagement. However, assessment criteria in cognitive learning engagements were recommended to be applied when improving students’ learning engagement; behavioral learning engagement criteria were easily affected by the other criteria.

Management implications

This study created the concept of cognitive learning engagement as a fundamental learning engagement, especially in reference to the student-oriented learning theories. In this study, it was found that intrinsic motivations were possibly produced by different cognition and impacts during the learning engagement process. Effective learning can only be observed when a student is qualified with a cognitive learning engagement, which echoes the results of Swann (Swann, 2013). Students should be more active during the learning process to reach the purpose of effective learning. The study examined the learning engagement theories by Appleton, Christenson and Furlong (2008) and Yazzie-Mintz (2010), revealing that cognitive learning engagement is the most influential category that could directly improve a student’s learning engagement. A4. Previews, assignments and reviews was the most critical item of the behavioral learning engagement criteria. Regarding emotional learning engagement, it was suggested that teachers assist students by forming a proper teaching environment to influence the students’ learning engagement. However the suggestion was more about the teacher’s participation, manifesting the diversity of student-centered and teacher-centered perspective outcomes. Thus, in practical application, the best combination is to make sure the student is qualified with cognitive learning engagement, teachers can then take part in forming a proper teaching environment to enhance student’s learning engagement.

Self-determination theory is worth mentioning in the study. The theory is based on autonomy, competence and relationship formed by motivational needs; different needs produce different learning engagements. Researchers suggested the inclusion of intrinsic and extrinsic motivation when conducting learning engagement research (McGarrigle, 2013; Zyngier, 2011).

Limitations and suggestions

The study provides assessment criteria for vocational college students’ learning engagement as well as the
methodology for administrators to improve teaching effectiveness and quality. However, the study has some constraints. For example, although the sample size was sufficient but the source was recruited only from seven vocational colleges, then external validity should be of concern. As a consequence, in theoretical framework construction, this study suggests that subsequent studies could clarify the more suitable definition and implications of learning engagement to enhance the effectiveness of researches. Regarding the research objects, this study suggests that the differences in the affecting factors of learning engagement between students, good and poor achievements, can be compared in order to extend the theoretical applicability. The study did not consider possible differentiation from the age and the background of the respondents, the maturation difference is suggested take into consideration in the series research. Last but not least, qualitative methodology and homogeneity sampling would be recommended in future studies to control possible confounders. Related variables and study design with regards to maturity are recommended for further investigation.

ACKNOWLEDGEMENT

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Wang, R. (2011). Assessment on Education Quality Criteria of University of Technology in Taiwan- using DEMATEL
Assessment Criteria of Vocational College Students’ Learning Engagement


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   Authors are named last name followed by initials; publication year goes between parentheses, followed by a period. The title of the article is in sentence-case, meaning only the first word and proper nouns in the title are capitalized. The periodical title is run in title case, and is followed by the volume number which, with the title, is also italicized or underlined.


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