Experience on Education Resource Integration in Biomedical Engineering

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Abstract

A successful engineering education focuses not only on the individual educational topic, but also on the integration of corresponding topics. That is, the effective engineering education can be enhanced by organizational education alliance to support multi-disciplinary education, learning, training, and practice mechanism. In this manner, the education resources of the governments, research centers, industries, and universities must to be integrated. The study of bio-medical engineering requires multi-disciplinary knowledge and skills which is a canonical example to address that viewpoint. Especially, the bio-medical engineering program considers the impacts of emerging technologies such as Bio-Tech, Nano-Tech and Info-Tech in 21 century. In this paper, an experience of the bio-medical engineering education resource center in Taiwan, named Medical Mechatronics Education Resource Center (MMERC), is presented. The MMERC was initialized in 1999, and it is sponsored by Ministry of Education (MoE), Taiwan. In addition to follow the government's strategies of "cultivating students with gearing international education chain", "introducing digital and distance learning", and "organizing student hands-on competition", the MMERC devotes itself to strengthening the organizational management (such as project planning, review, execution, tracking, and evaluation), academic-industry cooperation education, and Internet-based teaching/ learning experience sharing (such as online teaching material and virtual experiment, etc.) There are currently more than 10 hospitals and biomedical related agencies and companies, 17 universities and 20 teachers join this center. Finally, the mission of increasing engineering education capacity for Taiwan's studentsso they may better meet the needs of the bio-medical industry is achieved.

Introduction

The fast increasing technologies demand the emergencies of the engineering educations. A successful engineering education depends no only on the capability of teachers, but also the educational resources such as teaching materials, instruments and equipments. To construct an effective and efficient engineering education environment, the national engineering education resource centers for specific areas are established in Taiwan. On the other hand, the medical industries are getting more important than ever, and they are widely used in the daily life. For example, the technical aids can assist the disabled person and elders for mobility and vocational assistances; the computer assisted surgery system can assist the surgeons to improve the surgical quality; the telemedicine system can be used for the remote healthcares; the new medicine inspection techniques can recognize the sign in advance; and so on. Although the medical industries are important, there is rarely successful medical industry in Taiwan. The research and development human resource is the key factor of a successful company. It is required to improve the research capabilities in Taiwan. The medical mechatronics [1, 3] education resource center was established to train the students having capabilities of developing medical products and equipments based on the cost-effective and time-efficient considerations.

The MMERC is continuously sponsored by Ministry of Education (MOE) Taiwan [9] for six years, and it was initiated to perform the medical mechatronics academic collaboration and education resource integration for the universities in Taiwan. Due to the specialized characteristics and limited educational resources, the teaching experiences and corresponding facilities of the universities can be shared and integrated to improve the overall students' capabilities in Taiwan. The MMERC proposes a multi-disciplinary education, learning, training, and practice platform based on the "cultivating students with gearing international education chain", "constructing digital and distance learning network", and "organizing national student hands-on competition". In this manner, the students are able to learn wide range of skills and knowledge through the distance learning web sites of the MMERC and the short courses and workshops. In addition, the students can improve the practice capabilities in terms of participating the national medical student hands-on competition. The teachers and students can demonstrate their works in the exhibition. They can also share the experiences of developing the medical products and interact with the other teams.

In addition, the MMERC also follows the government's strategies and predict theindustrial trends to specify the annually goals and missions so that the students can meet the industrial needs. On the other hand, the MMERC devotes itself to strengthening the organizational management (such as project planning, review, execution, tracking, and evaluation), academicindustry cooperation education, and Internet-based teaching/ learning experience sharing (such as online teaching material and virtual experiment, etc.). There are currently more than 10 hospitals and medical mechatronics related agencies and companies, 17 universities and 20 teachers join this center. The capabilities of the students who attend this project are improved based on the annual evaluation. Meanwhile, the activities and members are growing. Finally, this paper is organized as introducing the MMERC, exhibiting workshops and short courses, constructing digital and distance learning network, organizing national student hands-on competition, and organizational management. Finally, we make the conclusions and propose the future works.

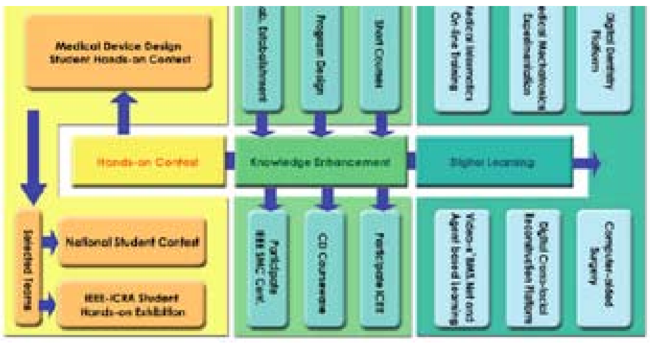
Introducing the MMERC

The MMERC is a non-profit organization, and it is sponsored under the MOE, Taiwan. The MMERC was initiated from the department of mechanical engineering, Chang-Gung University (CGU) in 2000. The MMERC aims to implement the government goal in making medical device localization, to promote academic-industry cooperative education, to educate medical mechatronics specialist with hands-on skills and to develop courseware and teaching materials, etc. The training objectives follows the student capacity model of $Cp = (K+S)^{A+C}$, and such a student capacity model forms the philosophy of MMERC for medical mechatronics personnel training. In this student capacity model, K means knowledge, such as domain knowledge, medical related theory and common senses; S means the skill, such as hands-on skill, experiment methods, and industrial practical training; A means the attitudes in positive, enthusiasm and executive habits; and C means creativity, and it is the abilities to make things different and better, as shown in Figure 1. The MMERC devotes itself to providing the engineering education resources exchange and sharing for the medical mechatronics industry. There are currently more than 10 hospitals, agencies and medical device related companies, 17 universities and 30 teachers registered in this center. In order to achieve the desired objectives, the MMERC execution mechanism is designed as also in Figure 1. In this figure, the core mission of the MMERC is identified as the "skill training" and "knowledge impartation". The core tasks consist of the theoretical and practical aspects. In the theoretical aspect, the teaching materials, learning planning, and international workshop of the medical mechatronics education are all specified and executed annually. In the practical aspect, the teaching aids, innovative design, and student hand-on competition of the medical mechatronics education are also developed and held annually. Especially, the distance-learning network is constructed to increase the transparence and efficiency of the skill training. The MMERC training activities is summarized as shown in Figure 2.

The MMERC web server [6] is captured as in Figure 3. On the other hand, in order to meet the timber requirements of the medical mechatronics industries, the medical related hospitals and associations are invited to cooperate with the MMERC such as the disabled aids association, disabled patient association, allied universities, allied industries, and hospitals. Finally, the international cooperations with the famous medical mechatronics related research laboratories are also encouraged to connect and synchronize with the international trends and results. On the other hand, due to the new developing technologies, the MMERC defines the map of technologies and requirements for the medical mechatronics engineering education, as shown in Figure 4. In this figure, the technologies are defined for the medical related industries, such as technical aids, medical facility and hospitals. In the current stage, the selected technologies are the mechatronics integration, micro electro-mechanical systems (MEMS), and nano technology.

Figure 1:MMERC Execution Mechanism

Figure 2:MMERC Training Activities

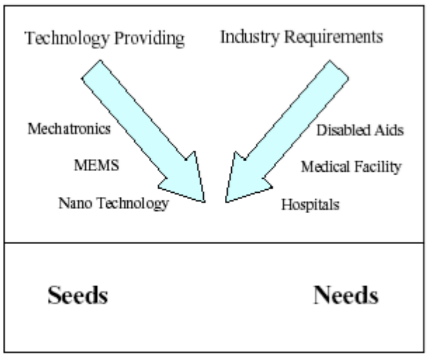


WORKSHOPS AND SHORT COURSES

The national workshop and short courses are one of the most important tasks of the MMERC. It aims to invite significant speakers to give the talks within the medical mechatronics. There are generally at lease 8 workshops and short courses held annually. The topics are solid and covering the sharing experiences of advising the students to participate the student hands-on competitions, the introducing of new technologies such as bio-MEMS, thermal imaging etc., the exposing of new medical mechatronics applications. In order to increase the interactivity of the allied universities, the national workshop and short courses are held at different allied universities.

Figure 3:MMERC Web Server for Education Resource Sharing

Figure 4:MMERC Seeds and Needs for Engineering Education



Especially, the educational instruments and facilities are allocated at the allied universities in terms of the considerations of speciality of the allied universities. The allied laboratories are responsible for sharing and training the allocated instruments and facilities in terms of exhibiting the national short course. Finally, there are totally 6 thousands students and interested employees participated the workshop and short courses. Figure 5 shows the photo of MMERC workshop.

Figure 5:Photo of MMERC Workshop

CONSTRUCTING DIGITAL AND DISTANCE LEARNING NETWORK

The digital and distance learning network is an important task of the MMERC. We construct the web server as the platform to share the teaching materials of the allied teachers. Four types of digital learning system are constructed: asynchronous static courses, asynchronous interactive courses, synchronous online courses and remote manipulations of instruments [4]. Note that the review board of the MMERC reviews the published course materials. The asynchronous static courses consist of the power point files of the workshop and short course of the MMERC and medical mechatronics specific courses of the allied universities. The students can access these course materials any time at any place through the network. Such courses are open and sharable to all interested readers. The asynchronous interactive courses focus on the practice and experiment courses. The allied teachers design the interactive courses of the instrument operations and experiment setting and procedures using the flash based interactive web pages and recorded video frames. Such an interactive course design is interesting and attractive to students, and it is effective to the learning efficiency. Figure 6 is an example of using interactive video frame. The synchronous online courses are used to broadcast the live videos of the workshop and short courses to who cannot participate the workshop and short courses. Due to the limitations of the network bandwidth, the synchronous online course is open to specific users who ordered in advance. The synchronous online course platform is constructed using software of “click-to-meet” [10]. The software of “click-to-meet” is a scalable solution for delivering online course voice, video, and data collaboration. The remote user can use a webcam and headset to participate the online courses.

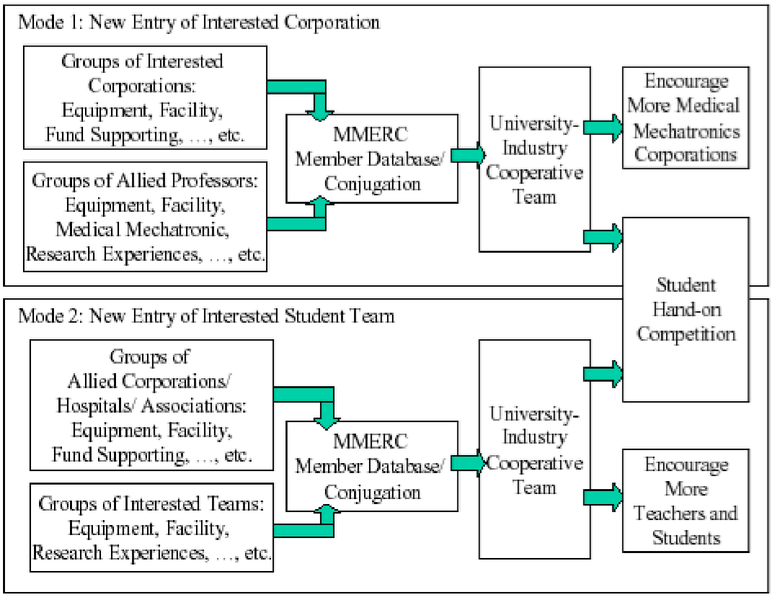
FIGURE 6:ASYNCHRONOUS INTERACTIVE COURSE

The remote manipulations of instruments are designed as a distance experiment course [4]. It aims to share the instruments and facilities of the allied universities through the Internet. The shared instruments and facilities must be capable of controlling by the computer programs. We also use the software of “click-to-meet” to construct the platform for manipulating the remote control programs. By investigating the monitoring webcam, the experiment can be finished. However, due to the sharing mechanism and security issues, this system is under test. Finally, there are totally 18 web courses published in the MMERC e-learning web site.

ORGANIZING NATIONAL STUDENT HANDS-ON COMPETITION

The student hands-on competition is one of the most important activities of the MMERC [2, 5]. In Taiwan, the developments and researches of the medical mechatronics systems are not popular in universities. The interested students may be suffered from the unreachable medical and clinical domain knowledge. Therefore, the MMERC’s student hands-on competition cannot be held similarly to the most hands-on competition. In addition to call for participation, we emphasize on encouraging more interested teams in terms of the supports from the MMERC allied industries and hospitals. The MMERC student hands-on competition team cooperation mechanism is shown in Figure 7. Such a competition mechanism is not only beneficial to the participated students and teachers, but also to the medical mechatronics industries. There are two possible university-industry team cooperation mechanisms. The first mode is designed for the interested corporations. The interested corporation can learn more system development experiences within the medical mechatronics from the allied professors of the MMERC. Based on the cooperative mechanism, the interested corporations are encouraged to post their problems or case studies and consequently look for supports. Then, the allied professors can cooperate with the interested corporation and advise their students to participate the student hands-on competition. Therefore, this mode will encourage more interested corporations to devote themselves to develop the medical mechatronics systems.

FIGURE 7:MMERC STUDENT HANDS-ON COMPETITION TAM COOPERATION MECHANISM



The second mode is designed for the interested student teams in universities. The interested teams can learn more medical and clinical domain knowledge within the medical mechatronics from the allied hospitals, associations, and industries of the MMERC. The interested teams are encouraged to discuss with the hospitals, associations, and industries in terms of the MMERC alliance network. In this manner, a cooperative team can be formed to propose a specified project. Consequently, the problems or case studies of the allied hospitals, associations, and industries can also be solved. Therefore, this mode will encourage more interested university teams to devote themselves to develop the medical mechatronics systems. By using the team cooperation mechanism, the MMERC student hands-on competition mechanism increases the engineering education capacity of Taiwan's students so they may better meet the needs of the medical mechatronics industry. In order to achieve the industry-academic-cooperation and practice experiences sharing objectives, the MMERC student hands-on competition is executed based on the scope, guideline and mission of Figure 10. In this figure, the competition team is formed based on the requirement and technology map as indicated in Figure 8. The MMERC defines the competition guideline and mechanism and call for proposals annually. The teams are forms as the members from university students and the supports from the industry and hospital. It aims to develop medical products with the practical requirements. The proposals are reviewed to validate the practicality of ideal and the quality of proposal. We do not only emphasize the practical capability but also the capabilities of the creativity and documentation. The participated teams are responsible to provide the teaching material, teaching aids, video demonstration, web course, and exhibitions for the experience sharing. In addition, the skilled teams are invited to exhibit workshops to share their experiences and to publish paper on international conferences. Therefore, such a competition mechanism meets the needs of the medical mechatronics industries. Finally, Figure 9 shows the photo of competition. In this figure, the students were demonstrating their product, and referees were evaluating and scoring their works.

FIGURE 8: STUDENT HAND-ON COMPETITION SCOPE, GUIDELINE AND MISSION

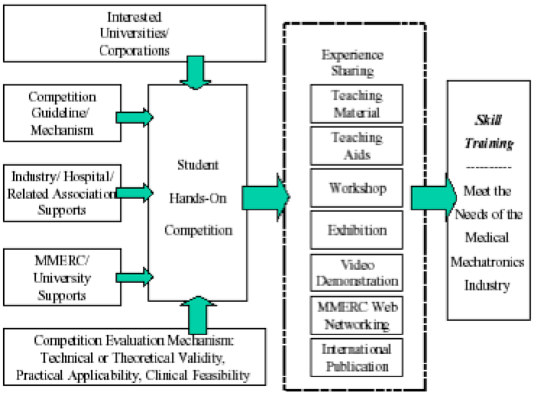


FIGURE 9: PHOTO OF MMERC STUDENT HANDS-ON COMPETITION

MMERC ORGANIZATIONAL MANAGEMENT

The MMERC is a significant medical mechatronics education center in Taiwan. In addition to provide the platform for education resource sharing and exchange, we exhibit the national workshop and short courses and the national student hand-on competition. We distribute the budgets and funds to the allied universities to contribute their works for the medical mechatronics engineering education. Therefore, the evaluations and reviews of the allied universities become crucial. To participate the works of exhibiting workshops and short courses, constructing digital and distance learning network, and participating national student hands-on competition are required to submit proposals. The proposals are evaluated by peer reviews. The referees are the experts form the academic universities, research organizations and medical industries. The peer review process ensures the hight quality of the execution tasks. In addition to the proposal review, the outcomes of the execution tasks are also evaluated annually. The annual evaluation of the allied university acts as the bases of decision-making for the next year projects.

CONCLUSIONS

This paper presents the academic collaboration and education resource interaction in medical mechatronics engineering. The MMERC is a national center in Taiwan, which was initiated to plan the future needs of the medical mechatronics engineering education based on the government policies and medical industry trends. In addition, we also promote the mechanism to share and exchange the educational resources such as course materials, instruments and facilities in terms of exhibiting workshops and short courses, constructing digital and distance learning network. In addition, we organize the national student hands-on competitions to stimulate the students' capabilities in developing the medical mechatronics products and sharing their practice experiences. Finally, the execution mechanism and experiences and the annual outcomes are all introduced in this paper. Based on the annual evaluation of the MMERC, the students' medical mechatronics system developments capabilities in Taiwan are improved.

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Exploring the Effectiveness of Applying Multimedia in Supporting Instruction and Learning in a General Engineering Education Course in Taiwan

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Abstract

This study applied multimedia into a general engineering course in Taiwan and attempted to evaluate the effectiveness of multimedia-assist instruction and learning. The course was designed for undergraduate students with variety of nationality, which introduced new technology development and achievements of Taiwan industries and research institutes from a historical approach. The contents included integrated circuit related industry, display industry, computer and information technology industry, nano and biomedical technology, agriculture and ecological research, and traditional industry transformation development in Taiwan that all have significant achievements in the world. During each class meeting, one or two technological topics were lectured accompanied with a 30-minutes multimedia video that presented relevant contents to enhance students understanding of the issues. All the videos were also mounted onto the course website for students to review after class. Research data were collected from 45 male and 9 female students and who came from different countries. Results showed that multimedia videos can help arouse their awareness of learning issues in the area improve students' understanding of contents, and the depth of their learning in the course. Almost all students liked the approach of using multimedia to assist teaching and learning; and they preferred this approach over traditional lecture-based instruction. And they would recommend this course to peers, too. Moreover, Students' degree of engagement would cause the variance of students' perceived helpfulness of video assists their learning in the general engineering education course. Finally, this study also proposed suggestions to both design and research in applications of multimedia enhanced learning in engineering education

Introduction

In an era of unprecedented technological advancement, engineering practice continues to evolve, however, engineering education, containing and emphasizing science and mathematics based-subjects, has not changed appreciably (Ang, Cruse, McVey& McMasters, 1999). It has been content-centered and design-oriented (Bourne, Harris & Mayadas, 2005), and often demands multi-disciplinary knowledge and skills. The Accreditation Board for Engineering and Technology (ABET) Engineering Criteria 2000 emphasizes outcomes over process, and provides an opportunity for stakeholders to help universities define educational goals and objectives and design a curriculum to meet the desired outcomes of technology advanced (Ang, Cruse, McVey& McMasters, 1999). Although many researches had explored different approaches to improve engineering education, yet more perspectives could be added to expand the possibilities of promoting engineering training. For example, general education could be an important context to engage students from non-engineering majors in engineering learning, or even to motive these students for advancing learning in engineering. There have been many courses offered in general education that present more basic knowledge of science, technology and engineering or introduce technology development involving engineering methods and techniques that intend o help students from different disciplines learn about engineering. However, not much research had paid enough attention to this approach for examining its effectiveness or ways to enhance learning engineering in general education course.

On the other hand, in recent practice of engineering education, there are more and more teachers apply multimedia to support their teaching, such as nanotechnology (Yueh & Sheen,2009), bioscience (Mutharasan, Magee & Wheatley, 1997), circuit and electronic (Maby, Carlson, Connor, Jennings& Schoch, 1997), computer and information science(Lang, Cruse, McVey& McMasters, 1999; Kartam & Reshaid, 2002) and so on. Multimedia is a technology for presenting material in both visual and verbal forms; it can combine verbal material such as printed and spoken text and visual material such as pictures, graphs, photos, dynamic graphics and so on (Mayer, 2001). Multimedia has the potential of creating high quality learning environment. It can enable teachers to choose from a range of media elements to convey a particular message (Cairncross & Mannion, 2001), illustrate spatial relationships (Sutcliffe & Faraday, 1994), and present different information toward different kinds of learners (Douglas,1993). When using multimedia in support of learning, it not only can help learners to recognize and retention the presented material but also to construct a coherent mental representation from presented materials (Mayer, 2001). It can further promote the depth of students' learning to specific issue and engage students in a way that static material does not (Cairncross & Mannion, 2001). Besides, Kim, Liu, & Bonk (2005) proposed that students°Ø different degree of engagement of learning would also affect their attitude toward learning. How to use multimedia to effectively engage students in learning engineering is also an important research issue in engineering education.

As a key player in world-wide technology industry, Taiwan government has been paying great attention to advance engineering education especially in higher education. Aside from many education programs for cultivating human resources in specific fields such as nano-technology, image and display technology, bio-medicine technology, there is another call for promoting science, technology and engineering in university general education. Besides, National Applied Research Laboratories (NARL), established in 2003 aimed to build up research and development platforms to support academic research, promote frontier science and technology, and foster high-tech manpower in Taiwan. This institute had produced a series of videos to introduce Taiwanese advance science and technology such as circuit related industry, display industry, computer and information technology industry, nano and biomedical technology, agriculture and ecological research, and traditional industry transformation development in Taiwan. To explore the effectiveness of applying multimedia in general engineering education, this study reproduced the videos release from NARL, integrated them into classroom teaching to provide students with the basic understanding of the technological development and outcomes of Taiwan. And an evaluation study was conducted to collect students' attitude toward video-assisted instruction and their perception of the helpfulness of this approach on their learning.

Method

Context

This study was implemented in a university general engineering education course offered in fall semester of 2008 in Taiwan. The course was designed for undergraduate students with variety of nationality, which introduced new technology development and achievements of Taiwan industries and research institutes from a historical approach. The contents included integrated circuit related industry, display industry, computer and information technology industry, nano and biomedical technology, agriculture and ecological research, and traditional industry transformation development in Taiwan that all have significant achievements in the world. During each class meeting, one or two technological topics were lectured accompanied with a 30-minutes multimedia video that presented relevant contents to enhance students understanding of the issues. All the videos were also mounted onto the course website for students to review after class.

Instrument

This study developed a questionnaire in order to realize the effectiveness of applying multimedia in supporting instruction and learning in a general engineering education course. There are three sections in the questionnaire: personal information includes gender, nationality, specialty; students' experience of watching videos in support their learning; students' attitude toward video-assist learning. For the attitude survey, the 6 point Likert-type scale was adopted for evaluation.

Data collection and Analysis

The questionnaire was administered to all students on the final class meeting of the course. Besides, this study used

Statistic Package of Social Science (SPSS 14.0) for descriptive analysis and ANOVA analysis.

Result

Subjects

Subjects of this study consisted of 54 undergraduate students registered in the general engineering education course "Scientific Taiwan" with valid returns of questionnaires. Of the total 54 subjects participating in this research, 45 were males (83.3%) and 9 were females (16.7%); and about one-third (31.5%) of them were foreign students from different countries. Besides, the students were from different departments with various majors; most of them claimed their specialty in bio-resources and agriculture (40.7%), as well as public health (31.5%). (See Table1)

Variable	**Frequency**	**Percentage**
Gender		
Female	45	83.3%
Male	9	16.7%
Nationality		
Taiwanese	37	68.5%
Foreigner	17	31.5%
Specialty*		
Bio-Resource and Agriculture	22	40.7%
Public health	17	31.5%
Law & Social Science	14	26.0%
Engineering	5	9.3%
Medicine	3	5.6%
Liberal art	3	5.6%
Science	1	1.9%

**Multiple-choice*

Students' Experiences of Watching Videos after Class

There were 17 students (31.5%) reported that they never watch video after class. For the rest 37 students, reasons for them to watch videos after class include they have to write class reports (44.4%); are interest in the lecture topics (27.8%); want to learn more information (20.4%); are used to review the contents learned in class (9.3%); and cannot follow up the class (3.7%). Researchers of this study tried to sort students with their learning engagement in terms of their video watching behavior, and categorized students into three groups: 13 students that actively want to learn more as positive learning group; 24 students for meeting assignment requirement as passive learning group; and those 17 students who never watched videos after class as none learning group. (See Table2)