Establishing a Nation-Wide Educational Program for Cultivating Professionals for Image Display Industry in Taiwan

Hsiu-Ping Yueh[1], *Hsien-Ta Lin*[2], *Li-An Chiu*[3], *An-Bang Wang*[4], *San-Liang Lee*[5]

[1,3]Department of Bio-Industry Communication and Development, National Taiwan University, Taiwan
[2]The Center of Innovation and Synergy for Intelligent Home and Living Technology,
National Taiwan University, Taiwan
[4]Institute of Applied Mechanics, National Taiwan University, Taiwan
[5]Department of Mechanical Engineering, National Taiwan University of Science and Technology, Taiwan

hsienta@ntu.edu.tw[2]

1. Abstract

The industry of image displays in Taiwan has grown rapidly to be one of the leaders in the world in the past four years and become a 80-trillion-dollar industry in 2008. To support the growth of this industry, one critical task is to build capacity of high-quality professionals from multi-disciplinary fields, such as optomechatronics, electrical engineering, and materials science. To reach this goal, we have developed a nation-wide educational program that has developed curricula and course materials, provided seed-lecturer professional development, encouraged academia-industry collaboration, and held hands-on student contests. In this study, we focus on the design of coherent curriculum. From a multiple regression analysis based on 3119 surveys from students, we found that the levels of students' understanding of the cross-disciplinary nature of image display is related to their perceived teaching quality, practical knowledge, and motivation for learning image display. The results of this study inform the design of education programs that aim to support understanding of multi-disciplinary topics in the context of large-scale curriculum implementation in universities.

2. Introduction: Shortage of professionals for the fast-growing image display industry in Taiwan

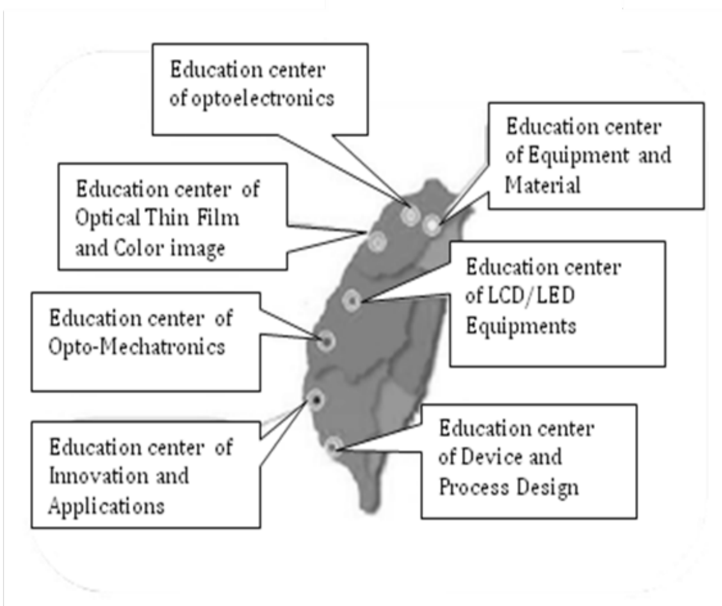
Image display industry is one of the largest and fast growing industries in Taiwan. The image display industry includes the flat panel display (FPD), image projectors, 3D display and flexible display. The revenue of the FPD industry in Taiwan increased from USD$ 8 billion to 60 trillion in 2007, and has reached 80 trillion in 2008. The industry will require 1800 engineers per year during 2008 to 2010. However, there was a shortage of professionals for the image display industry.

One of the major challenges in recruiting people in the fast-growing image display industry is that candidates usually don't have enough practical experience and complete knowledge of this field. There was no formal and extensive academic curricula design specifically for the image display industry in Taiwan. The display industry requires engineers who have knowledge from multiple disciplines, such as electro-optical and electric engineering, information science, mechanical engineering, material science, and chemical engineering. However, there was very few image display programs in the universities in Taiwan and the number of graduates is far less than that required by the image display industry.

3. The national education program of image display (NEPID)

To fill the gap between demand and supply in terms of qualified engineers in the rapid-growing image display industry, the Taiwan government funded the national education program of image display (NEPID) whose goal is to reach more students and teachers who are not identified themselves as members of the image display industry. The program office has set up seven regional education centers geographically distributed in Taiwan to serve as hubs for regional resources. Based on local resources and core competence, each of these regional centers focuses on one of the following areas: Optoelectronics, Equipment & Materials, Optical Thin Film and Colorimetry, LCD/LED Equipments and Process Technology, Opto-Mechatronics, Innovation & Applications, and Device & Process Design (as shown in Figure 1). The regional education centers are in charge of developing the image display education programs and serve as the regional resources and/or equipment centers for the partner colleges and universities. Overall, the seven regional centers partner with 40 regional colleges/universities.

Figure 1. The seven regional centers for image display technologies in Taiwan



This program has three specific objectives: first, to develop undergraduate and graduate curricula, course materials, and distance education program; second, to develop university faculty as seed lecturers who can teach courses related to image display to expand the teaching capacity in higher education; and third, to promote collaborations between academic institutions and industries for students to better link their learning to practical contexts. This paper focuses on the development of coherent curriculum and courses.

4. Building capacity of multi-discipline professionals by developing coherent curriculum and course materials

Coherent curriculum materials are critical for helping students develop integrated understanding of science concepts. Recent standards-based reform movements have encouraged curriculum researchers and developers to address content standards and benchmarks using more complex designs that weave scientific ideas together across multiple lessons and activities [1] However, creating materials where lessons are linked to standards does not guarantee quality learning experiences [2]. The parts of coherent curricula need to be connected together in a manner that helps students develop deep understanding of important ideas in a subject domain [3]. Without coherent connections between various parts of curricula, students may develop fragmented understanding of important science concepts [4, 5]. With more coherent understanding of scientific subject matter, students will be able to apply what they know to make sense of everyday scientific phenomena using strategies that are closer to those used by domain experts [6, 7].

5. Research questions

In this study, we aim to evaluate how the coherent curriculum contributes to students' understanding of the image display technologies. The research question is: How is student's improved understanding of image display technologies related to their demographical background, department, prior knowledge, motivation, and teachers' teaching quality? Our hypothesis is that students who receive better teaching and whose department is closer to image display technologies will have better understanding.

6. Methods

In order to evaluate the effectiveness of the program, the research group sent an online survey to all students who participated in the program to collect information of students' understanding of general knowledge, evaluation of instruction, and understanding of image display industry. For each items in the survey, students select from 1 to 6 to indicate the level of agreement (1: least, 6: most). A score was generated for each item based on the selected value.

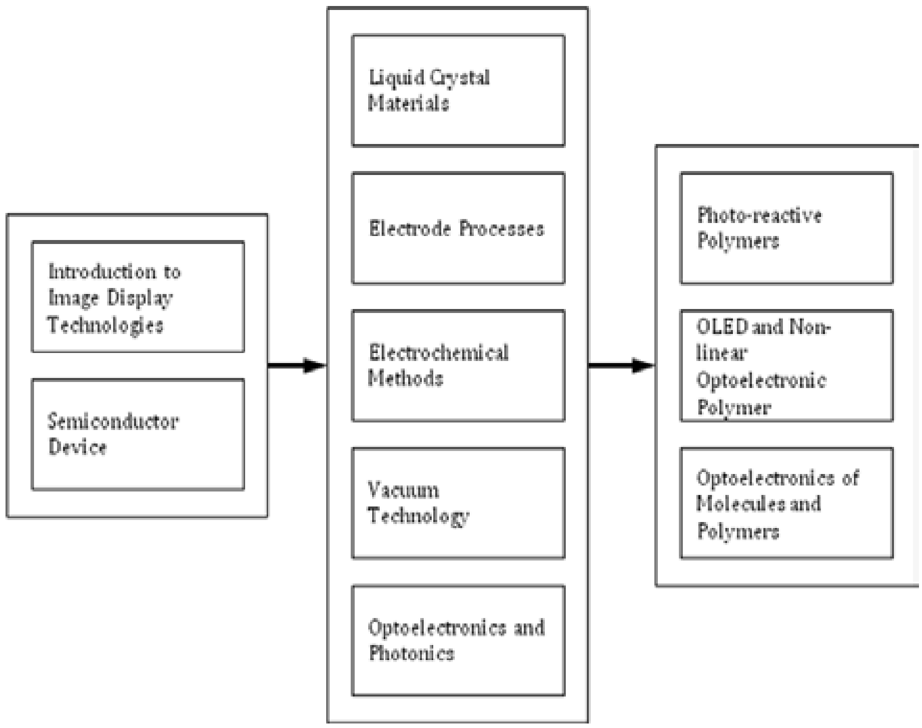
7. Results

7.1. Curriculum development

In order to develop coherent multi-disciplinary curricula and courses, the program has invited 28 faculty members to organize a curriculum committee. The committee members came from various fields, such as photonics, electrical engineering, mechanical engineering, physics, chemical engineering, material science. Experts from the industry are also invited to work with professors in developing courses used both for students and engineers.

Curriculum designers of the NEPID program have constructed coherent curricula by arranging big ideas in image display so that the courses introduce more fundamental concepts with observable phenomena before introducing deeper or abstract concepts. Appropriate phenomena not only engage students by creating a sense of purpose for technology concepts, but can also help them view these concepts as relevant to daily life [8]. Our coherent curricula also guide students to revisit concepts and engineering practices in different grade levels and across disciplines. We also demonstrate the relationship between fundamental principles and phenomena that enables learners to integrate new ideas into what they already know [6]. Figure 2 shows an example of the curriculum for flat panel display technologies.

Figure 2. Curriculum for flat panel display technologies in the NEPID program

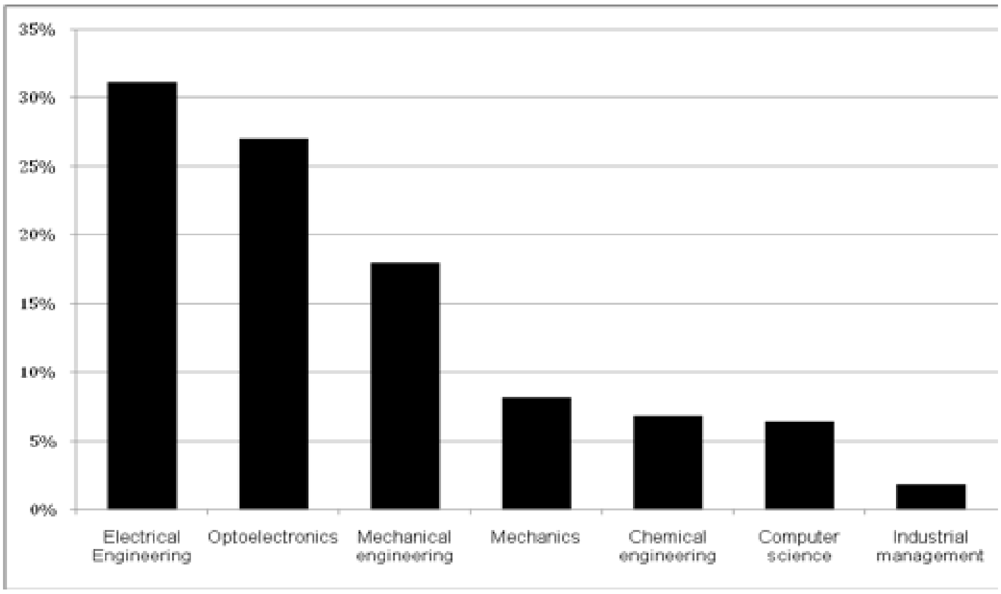


A series of curriculum materials have been developed for teaching image display technologies. They fall into four categories: (1) Fundamental photonics; (2) Image display modules; (3) Material, equipment, and manufacturing process; and (4) Circuit design for image display components. In the past three years, twenty curricula and 241 courses related to display technology are offered. In 2007, there were 86 industry-university courses given from the cooperation between universities and 92 enterprises/companies. Seven teaching materials are developed by the cooperation between universities and nine enterprises/companies. Overall, 9027 students have taken these courses.

7.2. Students' perceived value of the courses

In total, there were 3125 students (40% of 7816 participating students) filled out the survey. Around 90% of the students are male, which represents the gender difference in choosing majors in science and technology of the sample population. Among the respondents, their majors varied in Optoelectronics, electrical engineering, mechanical engineering, mechanics, chemical engineering, computer science, and industrial management. (See figure 1) Students from electronic engineering (31%) and mechanical engineering (18%) comprise half of the student group. And only 27% of the students major in photonics.

Figure 1. Percentage of students from different departments



Overall, the students gave an average score of 4.3 (out of 6.0) for their perceived improved understanding in image display technologies. The score for teaching quality is 4.6. About 60 percent of students expressed that they took the course because they were motivated to know more about image display technologies. About half of the students took the course because they wanted to learn skills required by the industry.

Results of multiple regression analysis show that teaching quality, knowledge of practical skills, and motivation to learn more about image display have effects on the amount of students' improved knowledge in image display technologies. The regression model is significant and of a moderate fit (R2adj = 32.5%, F3,3116 = 501.714, $p < 0.001$). With other variables held constant, the improved understanding of image display technologies score increases by .28 for every extra score in teaching quality ($t=28.16$, $p<.001$), increases .03 for every extra score in knowledge of practical skills ($t=11.81$, $p<.001$), and increases .02 for every extra score in motivation to learn more about image display ($t=8.429$, $p < 0.001$).

8. Discussion and implications

The finding of the study shows that the curricula and courses developed by the program help students improve their understanding of image display technologies. In addition, students were satisfied with the quality of teaching. Finally, students' learning of image display technologies is related to their instructors' teaching quality, practical skills, and motivation to learn about image display technologies. These findings show that the education program helps students from different departments and geographical areas around Taiwan. It also means that the program reached students who did not identify themselves as related to image display industry.

The education program described in this paper demonstrates a model for developing effective curriculum and faculty training for image display technologies. The model of developing coherent curriculum can also be used for other domains that need to develop engineers who know multidisciplinary knowledge. Engineering researchers and educators can apply this educational model in countries where the resource for universities in not even among different geographical areas. In the future, we will examine the roles of distance education in helping students in remote areas learn faculty members in more resourceful schools. Engineering educators should focus on improving instructors' teaching quality, providing students opportunities for building practical skills, and increase students' motivation to learn about image display technologies.

References

01. Y. Kali, M. C. Linn, and J. E. Roseman, "Designing coherent science education: Implications for curriculum, instruction, and policy," New York: Teachers College Press, 2008.
02. W. H. Schmidt, H. C. Wang, and C. C. McKnight, "Curriculum coherence: An examination of US mathematics and science content standards from an international perspective," Journal of Curriculum Studies, vol. 37, pp. 525-559, 2005.
03. F. M. Newmann, B. Smith, E. Allensworth, and A. S. Bryk, "Instructional program coherence: What it is and why it should guide school improvement policy," Educational Evaluation and Policy Analysis, vol. 23, pp. 297-321, 2001.
04. Kesidou and J. E. Roseman, "How Well Do Middle School Science Programs Measure Up? Findings from Project 2061's Curriculum Review.," Journal of Research in Science Teaching, vol. 39, pp. 522-549, 2002.
05. L. Stern and J. E. Roseman, "Can middle-school science textbooks help students learn important ideas? Findings from Project 2061's curriculum evaluation study: Life science.," Journal of Research in Science Teaching, vol. 41, pp. 538-568, 2004.
06. M. T. H. Chi, P. Feltovich, and R. Glaser, "Categorization and representation of physics problems by experts and novices," Cognitive Science, vol. 5, pp. 121-152, 1981.
07. J. E. Roseman, M. C. Linn, and M. Koppal, "Characterizing Curriculum Coherence," in Designing coherent science education: Implications for curriculum, instruction, and policy, Y. Kali, M. C. Linn, and J. E. Roseman, Eds. New York: Teachers College Press, 2008.
08. C. L. Smith, M. Wiser, C. W. Anderson, and J. S. Krajcik, "Implications of research on children's learning for standards and assessment: A proposed learning progression for matter and the atomic-molecular theory. ," Measurement: Interdisciplinary Research and Perspectives, vol. 4, pp. 1-98, 2006.
09. R. Collopy, "Curriculum materials as a professional development tool: How a mathematics textbook affected two teachers' learning," Elementary School Journal, vol. 103, pp. 287-311, Jan 2003.
10. E. A. Davis and J. S. Krajcik, "Designing Educative Curriculum Materials to Promote Teacher Learning," Educational Researcher, vol. 34, pp. 3-14, 2005.
11. L. S. Shulman, "Paradigms and research programs in the study of teaching: A contemporary perspective," in Handbook of research on teaching, 3rd ed, M. C. Wittrock, Ed. New York: Macmillan, 1986, pp. 3-36.
12. R. T. Putnam and H. Borko, "What do new views of knowledge and thinking have to say about research on teacher learning?," Educational Researcher, vol. 29, pp. 4-15, Jan-Feb 2000.
13. L. S. Shulman, "Those who understand: Knowledge growth in teaching," Educational Researcher, vol. 15, pp. 4-14, Feb 1986.