Development of a Bachelor Degree Program for Skilled Students

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Structured Abstract

BACKGROUND

In the fall of 2013, a new bachelor program, the Applied Science and Technology (AST) program, was established at National Taiwan University of Science and Technology. The program is a two-year program, and it accepts third-year students who have excellent skills. Here, "excellent skills" means that these students have been ranked top in a national skills competition, or even in Worldskills, a well-known international skills competition. The aim of the AST program is to allow the students to become professionals with global perspectives. The program is different from the other professional education in Taiwan. The difference is that each student in this program has a customized curriculum: the students only need to take the technical courses that are related to their skills. The reason to make this change was to allow AST students to perform better in academics due to fewer compulsory courses, and for the students to have more time to improve their skills and their English proficiency.

PURPOSE

The AST program has been implemented for only one year. No similar program has previously existed; consequently, we wanted to understand if the program was on the right track. The objective of the research was to evaluate the performance of this AST programs based on the responses from students, advisors, and an internship employer.

METHODS

We used both surveys and interviews to evaluate the AST program. We surveyed eighteen students, eight student advisors, and one internship employer by using questionnaires. In addition, we also interviewed two internship students in a foreign country, and used the interview results and the comments from their internship advisor as part of our evaluation.

RESULTS

Based on the survey, the internship employer was satisfied with two out of three AST students. Regarding the accomplishment of the educational objectives and the student learning outcomes, many of the students' performances are rated at excellent or good levels by their advisors and themselves; a few students' performances are rated as average. The interview results also showed that two students who were interviewed were satisfied with the program, and the advisor who interviewed them was also pleased with the students' work.

CONCLUSIONS

We used the survey and the interview to assess the AST program for skilled students. Most of the feedback from the internship employer, the advisors, and the students was satisfactory or above average, from which we may infer that the AST program is well established and focussed on its objectives. We are confident that the program can lead to a new direction for current professional education in Taiwan.

KEYWORDS

Skilled students, customized curriculum.

Introduction

In Taiwan, both the senior high-school system (10-12 grades) and the university system are two-track. A student graduating from a junior high school (7-9 grades) can then enter a general senior high school and then undertake a general 4-year college/university program, or he/she can enter a senior vocational high school and then take a 4-year college of technology/university of science and technology program. Both systems allow the student to obtain a bachelor degree. In the fall of 2013, a new bachelor program, the Applied Science and Technology (AST) program, was established at National Taiwan University of Science and Technology (NTUST), Taipei, Taiwan. The program is a two-year program, and accepts the third-year students who have excellent skills. Here, "excellent skills" means that these students were ranked top in a national skills competition, or even in Worldskills, a well-known international skills competition. Many of the people who attended the skills competitions were trained in their vocational high schools in Taiwan. After the competitions, most of them continued their study in universities. In the past, some of these students with excellent skills did not perform well in academics or even failed in universities because they spent too much time practicing their skills and too little time studying in their vocational high school. When they entered universities, they could not catch up. This is not only an example of student failure, but also of society's loss. On the other hand, some other students with excellent skills did succeed in academics. However, they were not satisfied with their curricula because many of their requisite courses were not directly related to their skills. This type of student could graduate without any problem, but they stopped improving the skills they had already learned; regrettably this negates all the time and effort they spent on their skills.

Traditional school-centered engineering education usually shows a gap between school and industry. For instance, Yadav and Huailin (2010) reported that a big gap existed between the requirements of universities and those of the software industry. Much research has mainly focused on how to link the courses offered in colleges to the requirements for industry in order for general students to bridge this gap. For example, Akhmed-Zaki, Mansurova, and Pyrkova (2014) reported the development of elective courses based on job market requirements. Qi, Terpstra, and Findlay (2014) reported an industry-oriented teaching and learning master program for students with a bachelor of engineering technology degree. Industrial projects and design projects from industry partners have been used to give students proper training. Nguyen, Truong, and Le (2013) reported that they used Capstone projects as their project-based learning and, as a result, improved the employment rate within three months after graduation from 88% to 99%. Maseda, Martija, & Martija (2012) used a modularized training tool so that students could work on different hardware or software modules concurrently and so improve their skills and motivation. Yang et al. (2011) reported an interdisciplinary course taught by seven faculty members from three colleges. The course was designed to teach students computational thinking and interdisciplinary teamwork, and especially targeted the students whose majors were not computer science. Qi (2008) applied industry-oriented teaching and learning strategies to traditional engineering programs. Demonstration and disassembly are examples of how to introduce industry products into regular theoretical courses. From a review of literature, it can be understood that the teachers are trying hard to diversify traditional courses by either introducing more industry related subjects into a course, or by including projects related to industry requirements into a course so as to minimize this perceived gap between school and industry. Little research on how to enhance the skills of a group of diversified students was reported.

To resolve the situation, the experimental program, the AST program, was thus launched in NTUST. Unlike the previous mentioned project-based or industry-based learning, the program is skill-centered learning with help from industry. The AST program consists of 50 credits, which can be completed within two years. Another 86 credits, which can be completed before or after the students enter this program, are needed for them to graduate.

The main difference between this program and the regular programs in NTUST is that there are less compulsory courses for students in the AST program. Instead, the students have more freedom to take the courses that are related to the skills they already have. In fact, both the student and his administrative advisor determine most of the courses that a student in this program has to take during the two-year period, so that each student in this program has his own customized curriculum. In the AST program, one administrative advisor and one technical advisor are assigned to each student. The administrative advisor is responsible for helping students make their study plans and monitoring the academic progress of their students. On the other hand, the responsibility of the technical advisor is to improve the students' skills. The benefits for students in having a customized curriculum are that they can focus on the courses related to their skills, and that they have less academic pressure compared to the regular students who need to take many compulsory courses, usually more than 70 credits in NTUST. However, the drawback of this program is that the AST students' knowledge base may also be narrower in comparison with the students in regular programs.

Currently, the students in the program are divided into four groups: electrical/computer technology, mechanical technology, architecture/civil technology, and chemical/materials technology as illustrated in Figure 1. Each student in this program has to choose one of the groups as his/her major group. Each group has three or four prerequisite courses as listed in Table 1. All the students are also required to take several common courses, including Occupational Ethics, Technical English, Applied Science and Technology Practice, Technical Project, etc. The required and elective courses of the AST program are listed in Table 2. Other than the previously mentioned courses, students are free to take any other courses under the supervision of their administrative advisor. The time they save from taking less compulsory courses is used to enhance their skills and to improve their English proficiency. The goal for the students in the AST program is to enable them to become professionals with a global perspective. To achieve this, all of the students are asked to take an internship for two months during the summer vacation or for four months during the regular semester. In addition, half of the students are supported financially by school to go abroad to such countries as Germany or New Zealand, for at least three months to help them gain a global vision. Each student is required to complete an engineering project before graduation to become capable of working independently.

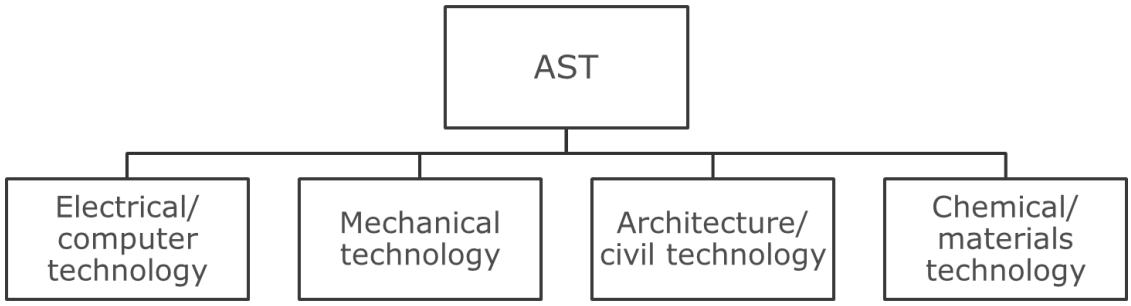

Figure 1: Four groups for the AST program

Table 1: Prerequisite courses for the AST program

Electrical/Computer Technology	Mechanical Technology	Architecture/Civil Technology	Chemical/Materials Technology
Introduction to Computer Science	Engineering Mathematics	Physics or Architecture Mathematics & Physics	Chemistry

Electronics	Physics	Calculus or Architecture Design	Physics
Calculus	Calculus	Introduction to Computer or Computer Aided Design	Calculus
Design of Digital Logics			

Table 2: Required and elective courses for the AST program

Course Title	Credit	Remark
Occupational Ethics	0	Students are required to take these courses (9 credits).
Technical English	3	
Technical Project	4	
Applied Science and Technology Practice	2	
Practical Training (I)	3	Students should take at least 3 credits (one course) among these courses.
Practical Training (II)	3	
Practical Training (III)	3	
Practical Training (IV)	3	
Electrical/Computer Technology Mechanical Technology Architecture/Civil Technology Chemical/Materials Technology	24	Students should take 38 credits from these courses, including at least 24 credits among the elective courses related to their groups. The courses for the 24 credits are offered by the related departments. For example, the students who are in the mechanical technology group need to take 24 credits from the mechanical engineering department.
Practice of Patent Search and Analysis	3	
Financial Management	3	
Introduction to Technology Management	3	
Internship in Applied Science and Technology	9	
Overseas Internship in Applied Science and Technology	9	
Summer Internship in Applied Science and Technology	3	
Technology Competition Project (I)	2	
Technology Competition Project (II)	2	
Technology Competition Project (III)	2	
Technology Competition Project (IV)	2	
Minimum credit requirement	50	

The AST program has been implemented for only one year. Because no similar program has been established in NTUST or even in Taiwan, we wanted to understand if the program was effective for the education of the skilled students. Consequently, the objective of the research was to evaluate the performance of the AST program in terms of the responses from the students, the advisors, and the internship employer.

Evaluation

We used both survey and interview methods to evaluate the AST program. Because the program is quite new and the people involved in this program are limited, the survey was conducted through one internship employer, eight advisors, and eighteen students. Regarding the interview, two students were interviewed while they were abroad working on an international project. The comments from the two students as well as those of the advisor on the two students are reported as part of the evaluation of the AST program.

Survey

We surveyed the students, the students' advisors, and the internship employer by using questionnaires. The questionnaire that we used to survey the internship employer is shown in Table 3, in which we also summarized the results of evaluating three AST students based on comments from their internship employer, who is a manager of a machine shop that makes moulds for optical products.

Table 3: Results of evaluating three AST students based on comments from their internship employer

Item No.	Contents	Very satisfied	Satisfied	Average	Unsatisfied	Very unsatisfied	N/A
1	work attitude	2			1		
2	presence			2	1		
3	executive ability		3				
4	human relationship	1	2				
5.	Following the order		3				
6	professional ability		2	1			
7	Work under stress		2		1		
8	quality of work		1	2			
9	team work		1	2			
10	communication skills		1	2			

11	creativity		1	2			
12	planning ability			3			
13	appearance		3				
14	integrity		2	1			
Overall performance			2	1			

From Table 3, it was found that the employer was satisfied with two students regarding their overall performance, but rated one student only average. After talking to the student who was rated average, we found that the student liked to learn new things from others when he finished his work. Not surprisingly, his work ethic was considered less than satisfactory by his employer. This situation was not helped by the fact that the student had a motorcycle accident during his internship, which affected his attendance.

More surveys were performed regarding the educational objectives and student learning outcomes of the AST program. Currently, there are four educational objectives of the AST program. They are: studying fundamental knowledge, emphasizing technical skills, enhancing English proficiency, and learning craftsmanship spirit. We conducted a survey, based on the advisors' and the students' input, about the achievement of the educational objectives, and the results are listed in Table 4. Regarding the objective of studying fundamental knowledge, most advisors rated their students at the level of good and average, which is similar to the self-assessment made by the students. Regarding the second objective, most advisors believed that their students did an excellent or a good job, while most (13 out of 18) students considered that they only did a good job. The obvious deviation about the results was for the objective of enhancing English proficiency. Five out of eight advisors gave an average rating to their students; however, 13 out of 18 students believed they performed at an excellent or good level. From our observation, many students did spend a substantial amount of time studying English, so they rated themselves very highly. The lack of an efficient means of evaluation was perhaps the reason that the advisors' assessment deviated from the students' self-assessment. Finally, most advisors and students agreed that the students did learn the spirit of craftsmanship though the AST program.

Table 4: Results of the survey on the educational objective. The numbers outside the parentheses represent the number of feedback from the advisors; the numbers inside the parentheses represent the number of feedback from the students

	Educational Objectives	Assessment				
		Excellent	Good	Average	Fair	Poor
1	Studying fundamental knowledge	1(1)	3(7)	5(9)		
2	Emphasizing technical skills	3(2)	6(13)	0(3)		
3	Enhancing English capability	0(7)	2(6)	5(4)	1(1)	
4	Learning craftsmanship spirit	5(7)	4(8)	0(3)		

The AST program has adopted and revised the ABET outcomes as listed in (ABET, 2011) for its student learning outcomes, which are listed in Table 5 and associated with the survey results. The advisors and students had similar assessment results for most of the outcomes

except for outcome 3 and outcome 7. For these two outcomes, the feedback from the advisors was distributed evenly in the three levels (excellent, good, and average); however, the feedback from the students centered at the good level. Output 3 is about creativity and output 7 is about ethics. Both cannot be easily evaluated objectively, which may account for deviation in assessment by advisors and students. For the other outcomes, the assessment shows that the students are, on average, all at a good level.

Table 5: Results of the survey on the student learning outcomes. The numbers outside the parentheses represent the number of comments from the advisors; the numbers inside the parentheses represent the number of comments from the students

	Student Learning Outcomes	Assessment				
		Excellent	Good	Average	Fair	Poor
1	an ability to proficiently use the knowledge, techniques, skills, and modern tools	2(4)	5(14)	1(1)		
2	an ability to conduct standard procedures; to conduct, analyze, and interpret experiments; and to apply experimental results to improve processes	1(0)	7(16)	0(3)		
3	an ability to apply creativity in practical techniques	3(2)	3(13)	2(4)		
4	an ability to manage projects; to function effectively as a member or leader on a technical team, and to be capable of effective communication	2(5)	4(9)	2(5)		
5	an ability to identify, analyze, and solve engineering technology problems	3(5)	4(9)	1(5)		
6	a knowledge of the impact of engineering technology solutions in a societal and global context; and a commitment to continuous study	1(3)	4(11)	3(5)		
7	an understanding of, and a commitment to address, professional and ethical responsibilities, including a respect for diversity	2(4)	3(11)	3(4)		

Interview

Two of the AST students worked in two laboratories in a German university of applied sciences for three months during this summer to gain experience in working with an international team. One student has been an exchange student in Germany starting from September this year. Another two AST students worked on an electrical vehicle (EV) project during this summer in the master's program at Otaga Polytechnic in New Zealand. An interview was held with these two students. Below is the summary.

One AST student completed his first two years' study in the architecture degree program and then entered the AST program. He has just completed his first year of AST. He is happy that he is keeping on track towards his architecture qualification (having selected the required courses as necessitated by the architectural profession so he could register with the professional body in Taiwan) and that he has gained wider knowledge and skills from other

disciplines. Having entered the AST program, he has gained confidence in his studies as well as in his professional pathway. He believes that he has more opportunities than his formal classmates in the architecture degree program in both academic and industry based learning. He also mentioned that the overseas experience has helped him to build positive attitudes about life and study.

The other student completed his first two years' study in the NTUST mechanical engineering degree program and has completed his first year in the AST program. His study has reinforced his travel along the professional pathway to mechanical engineering. He also agrees that the AST program provides many more opportunities for practical experience as well as engendering a positive attitude to life. He is happy to be in the position of being able to build overseas experience.

Both mentioned that they have more time to learn the industry-based skills, which encourage them to thoroughly understand the theoretical teaching contents and achieve the learning outcomes. They believed that they became better team workers in a multi-disciplinary environment.

The two students' advisor also commented on their works. He said that they had applied the skills learnt from the AST program to solve the practical problems in the project team, that they had done excellent work in demonstrating a 3D software model for the existing electric vehicle (EV) prototype and had identified existing technical issues in the EV. As a result they had come up with solutions. Currently they are applying the existing design method to build a new design of an EV.

In summary, we may infer from the results of the surveys and interviews that the objectives of the AST program are mostly achieved, the student learning outcomes are generally satisfactory, and most of the employer, the advisors and the students are pleased with the AST program.

CONCLUSIONS

The existence of the AST program in NTUST is barely a year old. Due to such a short period of time, there are no substantial data that can prove or disprove the success of the program. However, the program makes a change to the current Taiwan's professional education, in terms of customizing the students' curriculum; students only need to take the technical courses that are related to their skills. The instructors do not need to lower the standard for the students in the same class thus eliminating some teaching problems. The students also have more time to improve their skills. From the results of survey and interview, we may infer that the current AST program is satisfactory for the students, their advisors, and the internship employer. We expect that the program will lead to new directions for current professional education in Taiwan.

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