Honors Educating on Engineers in the Future

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Abstract. Elite education has been transferring to popular education due to the massive enrollment expansion of higher education in China since 1998, and engineering education of undergraduate in China has been becoming mostly in favor of intensive hyper-specialize while lack of essential general education. Honors engineering education, a forefront of innovations in engineering education, has expected to serve as the foundation for reform of undergraduate education. As a result, Yingcai Honors College of UESTC (University of Electronic Science and Technology of China) has been established as a laboratory for reform of engineering education of undergraduates. Program introduction, student selection, enriched curriculum, academic training, and other administrative details are described in the paper.

Introduction

Massive enrollment expansion of higher education is an inevitable result of social development and globalization by promoting the popularization of higher education in China, while it transfers higher education from elite education to popular education [1]. As a consequence, there are more and more challenges in terms of the quality of higher education, such as high student/faculty ratio, employment quality and academic infrastructure. For instance, from its founding in 1956, when a small group of students gathered to formally study wireless, to 2017 when it has grown to a vibrant 33,000-student research university with students from all over the nation and most countries in the world (with student/faculty ratio 8.78), UESTC is now a National 985 and 211 Key university, covering all-around programs in electronic disciplines. It now turns out to be a key multidisciplinary university with electronic science and technology as its nucleus, Engineering as its major field and integration of science, engineering, management and liberal arts. In general curriculum the possibilities for individualization and differentiation in content and didactics are often limited, which focus mainly on the average student to guarantee the bachelor’s level for all students. It might cause losing the interest of excellent students who are looking for an additional challenge.

Another issue on undergraduate education is about the balance between general education and professional education where most undergraduate education is inclined to become intensive hyper-specialized while lack of essential general education. In fact, the cultivation mode of engineering education in China has been deeply affected by the former Soviet Union, which specifies one major for each freshman when he/she is just admitted to university [2]. As an example, renowned as China’s cradle for the national electronic industry, there are more than 60 majors closely related the field of electronic science and technology in UESTC with about 3800 staff and 5,000 undergraduates each grade.

In order to keep the quality of elite education and provide some degree of general professional education, Yingcai Honors College of UESTC has been developed to attract outstanding students and provide opportunities for fully developing their potential, while it serves as a laboratory for reform of engineering education of undergraduates. Yingcai Honors College, established in 2009 who grew out of the 4-year honor program of Cheng Dian Yingcai Plan created in 2007, offers profound and in-depth study chances for highly talented students in UESTC. It takes advantage of UESTC’s disciplinary resources in electronic engineering and information science, as well as a high-level faculty aiming at training students into leading innovators with a solid fundamental knowledge, outstanding practical ability, highly comprehensive quality, global vision and enduring...
competitiveness in the field of electronic information. Students here represent a diversity of academic backgrounds spanning all major in information science and electronic engineering on campus.

The remainder of this paper will describe student selection, education pattern, enriched curriculum, leadership development, academic training, and other administrative details.

**Student Selection and Dynamic Management**

College and university admissions in China are centralized processes via standardized tests called National College Entrance Examination (NCEE). Each university and college selects applicants based on applicants' NCEE score from the highest to the lowest until the admission quota is reached [3]. Honors College has usually served as a beacon attracting outstanding students to University [4].

Yingcai Honors College attracts a significant number of outstanding students each year. About half students are incoming freshmen who came out among the top candidates of UESTC with extraordinary high score in the NCEE. And another half students are currently enrolled freshmen based on their impressive performance in the interview among the applicants. All the candidates are the top 10% freshmen of the majors in Engineering or Science campus-wide, who are asked to submit a written application including a statement of interest documenting their leadership and/or innovative aspirations, activities and experiences. It’s worth mentioning that the selection process involves not only the academic performance but also the academic pursuit or plan, as well as the evidence of leadership skills and innovative capabilities of those candidates.

Our honors college adopts an open and circulating system in which outstanding students from other college in UESTC get chances to join through interview, and certain students unadaptable to the college's education mode may choose to leave or be eliminated.

**Education Pattern**

It has become evident that there is a crucial requirement for change in the practice of engineering and the education of future engineers. Engineering disciplines specifically need to be broadened and enriched to better prepare graduates for developing in an eternally changing global economy driven by the explosion of knowledge, globalization and other factors [5]. Future engineering education favors the pattern of general professional education rather than intensive hyper-specialized education, who are required to develop an enhanced understanding of non-engineering disciplines such as business, art, and to comprehend the impact of engineering on the environment and the economy [6].

![Figure 1. Education pattern in Yingcai Honors College.](image)

Yingcai Honors College adopts unique and independent education pattern, called “3+1 Mode” from 2007 to 2015 and being changed to “2+2 Mode” since 2016, which is hopefully conducive to encouraging students to aspire to the M.S. and/or Ph.D. degree. Figure 1 illustrates an academic-year-based timeline for the student experience in our honors education. In the first 3 academic years, students mainly focus on acquisition of an extensive and solid basis in Humanities, Mathematics, Physics, Chemistry, Biology and core courses in the fields of electronic information and science. In the senior year, students can choose professors in the fields they are interested in as
their supervisors so that they can complete their undergraduate program, and participate engineering and academic training under professional guidance, as well as prepare for their Master or PhD programs and researches.

After completing the honors education program, students will receive their graduation certificate and diploma. The more excellent ones will receive honors certificate of UESTC. All graduates are qualified for admission to graduate waived of National Entrance Examination. Among all the graduates, about 90% pursue their postgraduate or PhD study all over the world. The number of graduated students and their further study are shown in Table 1.

<table>
<thead>
<tr>
<th>Year of Graduate</th>
<th>Num. of Student</th>
<th>Further study in Homeland</th>
<th>Further study Abroad</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>69</td>
<td>68.10%</td>
<td>20.30%</td>
</tr>
<tr>
<td>2015</td>
<td>64</td>
<td>71.90%</td>
<td>20.30%</td>
</tr>
<tr>
<td>2014</td>
<td>91</td>
<td>78.00%</td>
<td>16.50%</td>
</tr>
<tr>
<td>2013</td>
<td>110</td>
<td>89.10%</td>
<td>9.10%</td>
</tr>
<tr>
<td>2012</td>
<td>113</td>
<td>88.50%</td>
<td>8.80%</td>
</tr>
<tr>
<td>2011</td>
<td>111</td>
<td>88.30%</td>
<td>7.20%</td>
</tr>
</tbody>
</table>

**Enriched Curriculum**

Both the Engineer of 2020 (E2020) Scholars Program supported by the National Science Foundation Scholarships of USA [7] and the Excellent Engineer Training Program established by the Chinese Ministry of Education [8] emphasize the outcomes of future engineers such as leadership, global awareness and understanding, systems thinking, innovation and entrepreneurship. A set of engineering education quality monitoring and assurance systems have been established in China since 2006. Adopting internationally universal outcome-oriented philosophies and standards, engineering education certification systems in China focus on outcomes and development of students’ communication capability, teamwork spirit, professional knowledge/skill, lifelong learning skills, good world outlooks and sense of responsibility.

Our honors education program adopted independent and different version of curricula from those general curricula in engineering, and provide the select group of students an enhanced background and training in leadership, entrepreneurship, innovation and communication. The educating curriculum focus on the following key points:

**Management and Leadership Development**

Future technical expertise are required to develop an enhanced understanding of both engineering disciplines as well as non-engineering disciplines, the management and leadership for instance, due to the advances in technology and globalization. As a consequence, our general education courses are enriched, such as Management and Leadership, Outline of Chinese Culture, Psychology and Academic Writing. Furthermore, there are plentiful public elective courses in general education on campus. Honors students are also required to have a comprehensive study in the fundamental courses such as Mathematics, Physics, English and some kernel courses in the area of electrical engineering.

While management and leadership skills and abilities development often begins in the classroom with some courses, it heavily relies on various practical skill development beyond the classroom, such as work experience, outside speakers and facilitators, team exercises and projects, and special assignment. Some honors students serve as peer tutors and mentors for other students, which contribute to promote leadership. Many honors students participate in student leadership and hold leadership positions in variety of student associations, such as youth league subcommittee, student union, innovative association and volunteer association which hold a lot of extracurricular activities. Some students join mathematical modeling team, ACM team, robot team, communication SEAT platform, IC scientific association and a variety of innovative associations, which are worthy opportunities for management and leadership development.
Renowned Faculty for Teaching and Guidance

Our honors college attracts a lot of interested faculty to come together to develop engaging courses and honors curriculum challenging students to grapple with the larger global issues of an increasingly interdependent and technological world. Most of them are National Renowned Teachers, experts such as the members of the National One Thousand Program, and ChangJiang Scholars. They are hired as course teachers, growing-up mentors and academic supervisors.

Lecturers not only teach knowledge, but also the methods and skills that will be needed in the future and guide students learning how to handle the various sources, how to synthesize and leverage it, how to communicate and represent it, and how to use it to solve problems. A growing-up mentor or life mentor provides small-scale personal guidance and strong interaction with no more than 2 freshmen. As students move through the curriculum and associated research opportunities, academic supervisors help them develop the skills of inquiry that lead to deeper understandings and discovery, doing academic research, publishing high-level academic papers and applying for patents.

Four-year Academic Training Programs.

Yingcai Honors program offers 3 to 4 challenging courses in the curriculum, which are generally designed as Project-based Learning (PBL) courses, to assist students developing self-directed learning skills. For instance, one of the challenging PBL course, called Chengdian Yingcai Chuangke in sophomore seminar joined the CDIO Global Initiative by adopting the concept of using Conceive, Design, Implement and Operate as the four stages of engineering skills that the students must acquire, some student’s works shown in Figure. 2. It is expected to explore practical education based on Maker education model from the perspectives of participation pattern, teacher-student interaction, learning content and environment.

In the freshman or sophomore year, Freshmen Seminar in small interactive groups are available for freshmen and basic engineering training in laboratory is required. In the senior year, basic academic training in research laboratory is compulsory for all honors students with the supervision of academic supervisors. Seniors will join the scientific research teams led by their advisors to participate in some research projects and complete the comprehensive scientific training at last year.

(a) The design drawing                                                (b) The control system

Figure 2. Project-based learning on Smart Home.

Broaden Global Vision.

The E2020 project has defined global awareness as being aware and respectful of cultural and international differences in needs and values, understanding how regional and cultural differences affect the engineering design process and engineering business enterprise in general, and being able to work effectively with others from different cultures [7]. In order to broaden perspectives and prepare well for the international academic exchanges, the practice of English and bilingual education in our honors education are highly valued. The international summer school program has been developed, which aims to bring students the frontiers of science, experience the essence of global multiculturalism, and promoting exchange as well as broadening horizons. Furthermore,
special budget are offered for students to study abroad. Every year, there are many students who are funded to study abroad such as Japan, USA, Australia, Singapore, Hong Kong and Taiwan. Some seniors have been financial funded by some famous universities abroad to do research and study in their last year. An average of 20% graduates are admitted by famous universities abroad to pursue their Master or PhD degrees per year.

**Conclusion and Discussion**

Yingcai honors College of UESTC plays an important role by challenging our most talented students to realize their full potential. Our honors students think that studying at the honors college is very beneficial and fruitful. Most of their postgraduate supervisors are unanimous that Yingcai honors graduates are well-prepared set of students with liberal arts and sciences interdisciplinary vision and methodologies, who are warm welcome to pursue their study.

However, there are many challenges on development of honors program. On the one hand, it is quite difficult to define exactly the core characteristics of the potential candidates. There is no agreement among experts about the best way to select students for honors program. What are the relationship between student entry characteristics and measures of social and academic integration to engineering learning outcomes? How to measure the student success as well as the success of the honors education? On the other hand, most honors program encountered many serious opposition among some faculties, students and other colleges on campus. The reasons are various such as its fairness by in favor of the privileged few to the detriment of the excluded many, extra cost and risk on teaching reform, the curriculum as a smorgasbord of offerings with more fundamental general courses lack of professional knowledge.

We believe that the active, engaged and aware honors students can improve the learning environment in their own classes as well as other classes, and benefit their institution even the higher education overall.

**References**


