

Relative Significance of Admission Criteria for the Chemical Engineering Practice School (ChEPS)

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ABSTRACT: The Chemical Engineering Practice School (ChEPS) at King Mongkut's University of Technology Thonburi (KMUTT) is an international Master's degree program emphasizing practical training in petroleum and petrochemical industry. Due to the uniqueness of ChEPS' curriculum, a large number of applicants apply to the program each year. The admission criteria used to identify qualified students include undergraduate grade point average (GPA), Test of English as a Second Language (TOEFL) score, and admission interview score. In the past, these criteria were arbitrarily scaled, resulting in prospective students with inconsistent academic abilities. Therefore, a more quantitative scale is needed to improve the prediction of students' performance in school. In this study, multiple regression and statistical analyses were used to establish a correlation between the above mentioned criteria and the graduating GPA from ChEPS. In general, most admission criteria were good indicators of students' performance with the undergraduate GPA being the most reliable criterion of predicting academic success. Interestingly, the interview score demonstrated little correlation with the students' academic performance.

INTRODUCTION

The Chemical Engineering Practice School (ChEPS) at King Mongkut's University of Technology Thonburi (KMUTT), established in 1997, is an international Master's Degree Program in Chemical Engineering [1]. The program was initially developed based on the successful practice-model at Massachusetts Institute of Technology (MIT) [2]. ChEPS' curriculum consists of one academic year (two semesters and one summer) of course work, one semester of research and one semester of industrial internship at a practice site. The traditional method of learning, i.e. classroom lectures and homework assignments are supplemented with problem-based learning in which students are challenged with real problems from production plants. In addition, the students are required to give no fewer than 30 oral presentations over the course of the program. With the problem-based learning, not only do the students learn to develop analytical and teamwork skills, they are also able to improve their communication skills as well as their English proficiency. In the second year, the students spend one semester at one of the following practice stations: Thai Oil Public, Co. Ltd., Rayong Olefins Co, Ltd., Aromatics (Thailand) Public Co., Ltd. and etc. This practice phase would not have been possible without a strong industrial linkage, which is typically missing in other Chemical Engineering Master's programs in Thailand. The practical experience prepares the students for their professional career path, enabling them to apply the fundamental theories from classroom to tackling real industrial problems. Furthermore, supports, including scholarships and monthly stipends, are offered to qualified candidates [3]. Consequently, these students can concentrate more on their studies while in school without having to worry about the financial burden.

The uniqueness of the program, especially the practical training, allows ChEPS to be one of the most competitive

Master's degree programs in Thailand. Each year, more than 100 applicants apply to the program, while only 18 - 25 qualified students are admitted. Selecting candidates with the best prospect for success is therefore critical. Multiple admission criteria have been employed when screening applicants which include undergraduate grade point average (GPA), Test of English as a Foreign Language (TOEFL), and interview.

Previous academic performance is often a good indicator of a student's future academic performance. Therefore, the undergraduate GPA has always been used as the primary criterion when evaluating applicants. The minimum GPA required to apply to ChEPS is set at 2.70 [4]. Table 1 shows the distribution of undergraduate institutions and average GPAs of admitted students from class one to class eight. These students were normally ranked in the top 10% of their undergraduate classes with an average GPA of 3.14 [5]. For earlier classes (class one to class three), the undergraduate GPA was used in conjunction with interview in the admission process. Both criteria were weighted equally (50% each). The interview was conducted with at least 3 faculty members associated with ChEPS program. The interview tested the candidates' English speaking skill, communication skill and occasionally basic understanding of chemical engineering fundamentals.

Later on, we realized that English proficiency was one of the key factors in academic success since learning in ChEPS is based heavily on English tuition. Lectures, presentations, and reports are all conducted in English. Moreover, KMUTT requires all students to score at least 500 on paper-based TOEFL upon graduation [6]. Thus, TOEFL was supplemented as an additional criterion to test a candidate's level of English proficiency. We believe that language barriers do affect the academic performance in ChEPS. An applicant with a good

command of English, as reflected by a high TOEFL score, is more likely to perform better academically. In the past, students with low TOEFL score tended to have difficulty graduating. Moreover, these students sometimes struggled to pass the TOEFL requirement.

Table 1. Academic Profile of Admitted Students in ChEPS [5]

University	Number of Average Students	GPA
Burapha University (BU)	5	3.04
Chiangmai University (CMU)	10	3.29
Chulalongkorn University (CU-CT)	7	3.34
Chulalongkorn University (CU)	13	3.12
Kasetsart University (KU)	34	3.04
King Mongkut's University of Technology Ladkrabang (KMITL)	24	3.14
King Mongkut's University of Technology North Bangkok (KMITNB)	15	3.09
King Mongkut's University of Technology Thonburi (KMUTT)	55	3.14
Khon Kaen University (KKU)	1	3.17
Mahidol University (MU)	11	3.09
Prince of Songkla University (PSU)	3	3.39
Silpakorn University (SU)	1	2.84
Srinakharinwirot University (SWU)	1	3.45
Suranaree University of Technology (SUT)	1	3.43
Thammasart University (TU)	12	3.18
University of Waterloo	1	Excellent Standing
Total	194	3.14

Over the past five academic years (class four to class eight), the relative importance of the admission criteria was quite subjective. The weighting factor of each criterion was changed qualitatively based on the outcome of the previous year. From our experience, we found the undergraduate GPA to be the most influential. Therefore, a weighting factor of 50% was always assigned to the undergraduate GPA. On the other hand, both the TOEFL score and the interview score were scaled arbitrarily, but never weighted more than 30%. Although English proficiency was considered important, more emphasis was still put on previous academic performance. A 25% weight was assigned to both the TOEFL score and the interview score for class four and class five. For class six to class eight, the weighting factors were changed slightly to 20% for TOEFL and 30% for the interview. Just last year, the math part in Scholastic Aptitude Test (SAT) was also included as one of the admission criteria to test applicants' technical abilities. This criterion helped ChEPS screen candidates more effectively.

To ensure consistent academic standard from year to year, an admission correlation should be quantitatively determined, and the criteria used in the admission process at ChEPS should be systematically investigated. In this study, we evaluated the relative importance of each admission criterion in predicting the academic success at ChEPS over the past eight academic years using a correlation-based approach. The academic success is measured in terms of the GPA at the

completion of the program. The impact of SAT score will not be included in this study because of insufficient data. The results from this study will be incorporated into the admission process next year.

METHOD

Sample and Procedures

The study population consisted of 194 students who were enrolled at ChEPS from 1997 to 2005 (class one to class eight). For classes one to three, the admission criteria used are undergraduate GPA and interview score. The GPA was calculated based on a 4.0 scale. The admission interview score was averaged from at least 3 faculty members. Each faculty member assigned a letter grade from A to F (where "A" indicates outstanding and "F" is fail) to the applicant's interview. These letter grades were later converted to numerical values between 0 and 30. The interview score is based on several factors including, English proficiency, clarity of expression, maturity, etc. Note that no interview guideline or no standardized question was used during the interview. For class four to class eight, paper-based TOEFL was also administered. The TOEFL scores ranged from 300 to 667. These scores were later converted to a 1.0 scale.

A student's academic performance was measured by the final GPA upon graduation from ChEPS. The cumulative GPA was calculated based on a 4.0 scale at the completion of his or her second year. In the summer and the first year, GPA was determined entirely by grades received in the required classes and the design-problem projects. In the second year, letter grades were assigned by industrial sponsors during the practical training phase and a thesis advisor during the research phase. Details of the ChEPS' curriculum are available from the program's web site [7].

Analyses

The data were analyzed by individually regressing each criterion with the graduating GPA. The regression analyses were also tested for statistical significance ($p < 0.05$). A *t*-test, unpaired and two-tailed, was also applied to evaluate the significant difference of the GPA between each institution and to determine whether a correction factor for GPA for each undergraduate institutions is necessary.

RESULTS AND DISCUSSION

The correlation coefficients between each admission criteria and the final GPA are presented in Table 2. It is clear that the undergraduate GPA has the strongest correlation with the final GPA in both cases (for classes one to three and classes four to eight). This finding is consistent with our expectation. Studying in ChEPS requires knowledge of chemical engineering fundamentals at the undergraduate level upon which more advanced concepts are built. A student with stronger chemical engineering background would have more advantages to excel in his or her study. As a result, a candidate with higher undergraduate GPA would likely to be more successful academically in ChEPS. This result shows that the undergraduate GPA is a good predictor for academic success. We believe that 50% weighting factor for this criterion is

appropriate. Although the understanding of chemical engineering concepts is a prerequisite as stated earlier, we sometimes admitted students who majored in other disciplines which are closely related to chemical engineering such as chemical technology or chemical industry. We did, however, have to pay special attention to their undergraduate courses to be certain that they were well-prepared for the intensive education in ChEPS.

Table 2: Correlation coefficients between each admission criterion and the graduate GPA

	r^2
Class 1 – 3 (n = 63)	
Undergraduate GPA	0.90
Interview	0.23
Class 4 – 8 (n = 157)	
Undergraduate GPA	0.73
Interview	0.07
TOEFL	0.41

The TOEFL score also shows a relatively good correlation with the ChEPS GPA ($r^2 = 0.41$). The average TOEFL score of students admitted into ChEPS is between 437 ± 40 . To some extent, English proficiency affected the ChEPS GPA. Students with lesser English proficiency would need more effort and time to complete their work. These students may experience heavier workload relative to their classmates who have good command of English. Furthermore, a score of 500 on TOEFL is required by KMUTT as one of the graduation requirements [7]. Therefore, extra hours outside classrooms are needed for students with low TOEFL scores to improve their English to pass the requirement. Interestingly, we have found the correlation coefficient between GPA and the TOEFL score to be around 0.16, indicating no relationship between these two groups of data and no redundancy between these two criteria. An applicant with high GPA does not necessarily have a good command of English. From our experience, we have found that the applicants' level of English proficiency is based largely upon their English education in high school.

The interview has been used extensively as an admission criterion to screen candidates. The regression result, however, shows that the interview score has little correlation with the ChEPS GPA. The correlation coefficients of this criterion for classes one to three and classes four to eight are significantly lower than those of other criteria ($r^2 = .023$ and 0.07 , respectively). This finding is consistent with the previous studies on other subjects [8]. The interview has been shown to be subjective and unreliable. Due to the time constraint, each interview slot was limited to 15 minutes. Therefore, it would be difficult to determine non-intellectual aspects of the applicants, such as motivation, interest, previous experience, maturity, etc. In addition, these emotional-quotient characteristics are difficult to quantify.

Another problem has arisen from the interview. Interviewing faculty members had access to each candidate's transcript and his or her TOEFL score during the interview. Therefore, it is possible that the interview score was influenced by the prior

academic information. This claim is confirmed by the result from Figure 1 showing the distribution of the interview scores of all candidates. It is clear that the admitted group shows higher average interview score (23.92 for the admitted group and 20.70 for the whole population). The distribution of the interview score in the accepted group is also narrower (standard deviation of 2.45). The interview results may be questionable. The interview can be improved by having a more structured interview process. Interviewers should follow a guide sheet with predetermined questions to ensure that all applicants would be asked the same type of questions. These questions must reflect certain qualities in each candidate and these qualities should be carefully quantified with numerical values based on an established guideline or agreement [9].

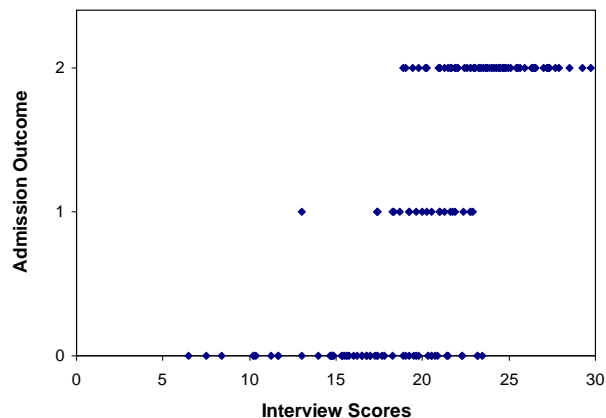


Figure 1: Distribution of the interview scores. Admission outcome: (0) indicates “rejected”, (1) indicates “waiting list”, and (2) indicates “accepted”.

Although the finding suggests that the interview has the least impact on predicting the academic achievement in ChEPS, the interview should not be removed from the admission process. The interview score can be particularly useful when dealing with special cases, for example, to determine which applicants should be moved up from a waiting list or to eliminate applicants with strikingly absurd personality. Therefore, the interview can be used independently as a first-round screening tool and used to assist selection committee in the decision-making process.

Since the undergraduate GPA is the best predictor for the academic performance as mentioned earlier, a larger weighting factor could potentially be assigned to this criterion. Generally, grading standards vary across undergraduate institutions. Thus, students from universities with more rigorous grading standards can be at a disadvantage if their GPAs are taken at face value during the admission process. Consequently, the variation among the GPA between each undergraduate institution should be thoroughly investigated. The necessity for GPA adjustment should also be verified. Table 3 shows the ratios of the undergraduate GPA and the final GPA in ChEPS and a correlation matrix between the GPA from each institution. This matrix shows that GPA from different institutions cannot be weighted equally. A correction factor should be assigned to balance the GPA before a comparison is made. All of the universities were grouped based on the result from this matrix and ranked according to the stringency of their grading standards, as shown in Table 4.

Table 3: Ratios between the undergraduate GPA and the final GPA at ChEPS categorized by undergraduate institutions. The intercorrelation matrix of correlation coefficients is also presented.

	BU	CU-CT	CMU	CU	KMITL	KMITNB	KMUTT	KU	MU	TU
RATIO	1.086	1.113	1.049	1.138	1.181	1.124	1.124	1.169	1.125	1.164
CU-CT	0.489									
CMU	0.360	0.067								
CU	0.214	0.457	0.020							
KMITL	0.029	0.021	0.000	0.153						
KMITNB	0.374	0.753	0.057	0.718	0.089					
KMUTT	0.286	0.652	0.015	0.626	0.003	0.999				
KU	0.047	0.054	0.001	0.308	0.566	0.182	0.027			
MU	0.334	0.704	0.038	0.723	0.064	0.974	0.965	0.149		
TU	0.082	0.161	0.006	0.489	0.583	0.322	0.203	0.874	0.304	

Our result indicates that the GPA of a student from KMITL should be adjusted before being compared with that of a student from KMUTT. The GPAs from KMUTT, KMITNB and MU are comparable. Because the GPA would have the most impact on an applicant's chance of being accepted, this issue needs to be addressed and a more accurate GPA institutional adjustment index should be developed.

Table 4: Undergraduate institutions grouped by GPA and ranked based on the leniency of their grading standards (from the most stringent to the most lenient)

Group	Undergraduate Institutions
1	KMITL
2	KU, TU
3	CU
4	KMITNB, KUMTT, MU
5	CU-CT
6	BU
7	CMU

CONCLUSIONS

The admission criteria used at ChEPS were evaluated to determine the relative importance of each variable. These criteria include the undergraduate GPA, the TOEFL score, and the interview score. In summary, the undergraduate GPA correlated most strongly with the indicated academic performance. The TOEFL score also showed a good correlation with the ChEPS GPA but to a lesser extent. Surprisingly, the interview score showed little correlation to the students' academic performance. To construct an empirical formula for the selection process, the undergraduate GPA should be given the most consideration, followed by the TOEFL score, while the interview score may be neglected. However, it is still necessary to conduct the admission interview which can be used in other subjective decision-making. Since the GPA has a large impact, a correction factor to the GPA for different institutions should be determined. This determination of the GPA adjustment must be thoroughly studied. Another standardized test, for example SAT, may be administered to help determine candidate's technical ability.

More studies should be conducted to determine an appropriate role of this test in the empirical formula for ChEPS' admission process.

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