

## Do secondary school grades predict the performance of engineering students? \*

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**SUMMARY:** *The current study examines the performance of students in the College of Engineering at UAE University and correlates it to their performance at high school. The performance of the students in the engineering program is evaluated based on the history of their grade point average (GPA) in the engineering program. Meanwhile, their secondary school final scores are used to evaluate their performance in high school. The results of engineering students are also classified according to the engineering discipline. Five different disciplines have been considered, namely architectural, civil, chemical and petroleum, electrical, and mechanical engineering. A prediction of the GPA in the College of Engineering is estimated based on the high school grades for 547 students. Results of students' performance are also examined per their secondary school location within the country.*

### 1 INTRODUCTION

Colleges try to admit students who possess characteristics that are indicative of their ability to earn passing grades at the institution in their chosen major. Students who lack academic ability cannot benefit from the education being offered. Often students' failure can mean that a college program may be admitting students who are not able, or the program may be failing to provide necessary support services to those who are able. Therefore, it is to the best interests of the institution and the student to assess accurately the applicant's potential to succeed at the institution (Gutmann, 1987). Specifically, institutions hope to predict the first semester college grade point average (GPA), because students who fail during the first semester of college often also fail to continue on toward graduation (Astin, 1993; Tinto, 1993; Richards et al, 1999). Unfortunately, predicting academic success in college is difficult, and students from various backgrounds possess individual characteristics (Lovegreen, 2003) and abilities that make this assessment even more difficult (Astin, 1993). High school grades provide college admission officers one good indication of student academic ability (Astin, 1993). However, they are not necessarily a good means of comparing students' experiences and

achievements. This is because high school grades reflect the standards and quality of a particular school or school system. These standards differ according to region, school district and even individual schools. These between-school differences are not reflected in high school grades. Therefore, using high school grades alone does not give admission officers a clear indication of how applicants across various educational systems compare to one another in ability (Burton & Ramist, 2001).

To solve this problem, a system of standard examinations was created to provide an assessment of the cognitive ability of potential students. These standard tests are normally offered by corporations that are unaffiliated with any educational institution or government agency in order to provide a consistent measure by which colleges can compare student ability (Willingham, 1985; Willingham et al, 1990). Standardised tests provide a quantitative measure with a focus on student ability in mathematics, analytical reasoning, verbal and writing skills that are not associated with a particular high school curriculum (Etzkowitz et al, 2000).

### 2 CEPA TEST IN UAE HIGHER EDUCATION

The Common Educational Proficiency Assessment (CEPA) began as a joint venture between the National Admissions and Placement Office (NAPO) in the Ministry of Higher Education and Scientific Research and the three higher education institutions

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in the United Arab Emirates (UAE): UAE University, Higher Colleges of Technology (HCT) and Zayed University. The ownership of CEPA by the three higher education institutions and Ministry of Higher Education and Scientific Research is registered at the Ministry of Economics. CEPA was developed originally to facilitate the placement of students for English language study purposes across the three higher education institutions.

From 2006, CEPA-English has been used to determine eligibility for placement into Higher Diploma and Bachelor's degree courses. Applicants must achieve a minimum score of 150 on CEPA-English, in addition to a minimum average of 70% on the GSC exam or equivalent, to be eligible for Bachelors' programs at the three institutions, and Higher Diploma programs at the HCT. Those scoring less than 150 on CEPA-English are automatically transferred to the HCT Diploma. Since 2006, CEPA has also included a mathematics component in order to facilitate the placement of students into mathematics courses at the three higher educational institutions. CEPA-Maths is used for placement in foundation mathematics programs only, and not for selection. However, CEPA-Maths is a compulsory part of the application process, and students without a CEPA-Maths score will not be considered eligible for higher education courses. CEPA-Maths has been administered to all NAPO applicants from 2008 onward. It covers all mathematics skills required for engineering students that were studied from Grade-1 through Grade-12.

From 2007, the CEPA-English exam has been administered to all students completing Grade-12 of the Ministry of Education English curriculum as the Semester 2 examination. The higher education institutions and NAPO collaborate with the Ministry of Education to deliver CEPA as the GSC-English Semester 2 exam. Students who have applied through NAPO to the tertiary institutions are sent their CEPA-English and CEPA-Maths scores in early June. They should not contact the institutions or NAPO directly for this information. All students have their scores on CEPA-English reported to the Ministry of Education, where it forms one part of the overall GSC-English score. CEPA exams cover all skills gained from Grade-1 through Grade-12 with multiple-choice questions, and students must gain at least 60% to pass and continue their study at the UAE University. Currently, there is no CEPA test on physics, although it is planned in the near future for all Grade-12 students. In all engineering programs at UAE University, there are two physics courses with laboratories and students need their secondary physics skills to pass these courses.

### 3 PURPOSE OF THE STUDY

The purpose of this study was to determine the relationship between the secondary school grades

and the GPAs during the engineering study of the students. The participants' GPA after two years of study, after four years of study and at graduation was used as the dependent variable. The secondary school grade was used as independent variable. The study was guided by the following research question: "What are the contributions of the secondary school grade to the success of engineering students?" (Geiser & Santelices, 2007). Although there is a significant amount of literature on characteristics or attributes required for successful completion of an engineering degree (Granlund & Anwar, 2004; Sorkin et al, 2007), most of this literature relates to America or Europe. This is why the current study may be of importance as it looks at this issue for the UAE students.

#### 3.1 Definitions

The following terms will be used throughout the study and are defined below:

- *Academic success* – in this study, the concept of academic success is determined by the persistence of a student within the college with a specific GPA. For the purposes of this study, students who are academically successful in college are those with a 2.0 GPA or above. This is the same GPA that the university takes as a minimum for the success of a student. If the GPA at any time is lower than 2, then the student will receive an academic warning. The student cannot be graduated at a GPA lower than 2.
- *GPA* – the definition of GPA in this study is based on the accumulation of all previous semesters' work. Table 1 shows the grade points assigned per letter grade used.

#### 3.2 Change in UAE University grading policy

In order to assure consistency across the three federal institutions in the UAE, and to reflect international standards in college and university grading practices, the grade point value of the grades B+, C+ and D+ will change for all currently enrolled and future UAE

**Table 1:** Letter grades associated with grade points (prior to Spring 2009).

Letter grade	Grade points
A	4
B+	3.5
B	3
C+	2.5
C	2
D+	1.5
D	1
F	0

**Table 2:** Letter grades associated with grade points (Spring 2009 onward).

Letter grade	Grade points
A	4
B+	3.3
B	3
C+	2.3
C	2
D+	1.3
D	1
F	0

University students effective for Spring 2009 classes and thereafter, as shown in table 2.

#### 4 METHODOLOGY

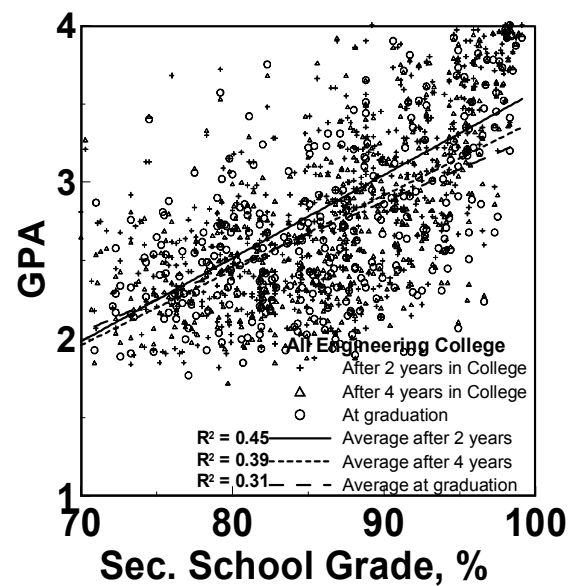
The relationship between the secondary school grades (as percentage) and the GPA is the main objective of the present study. The secondary school final grade and the GPA for 547 students in the College of Engineering at UAE University have been traced from the students' transcripts. The GPA for all students participated in the study has been traced at three different points. The first point is after two years from the entry to university, while the second point is after four years of study and the last point is at graduation, which was the first semester of the year 2008/2009. Five different disciplines have been considered, namely architectural, civil, chemical and petroleum, electrical, and mechanical engineering. In this study, the departments have been renamed A, B, C, D, E and F, without order, so they cannot be identified. A prediction of the GPA in the College of Engineering is estimated based on the high school grades for a 547 students.

#### 5 RESULTS AND DISCUSSION

Figure 1 shows the relationship between the secondary school grades in percentage as a function of the GPA for all the students sampled. The figure illustrates the accumulative GPA after two years from college entry, after four years and at graduation. It also shows the average GPA at each secondary school grade as straight lines. It may be seen from this figure that the GPA for all students generally improves and increase as their secondary school grades increases. The higher the secondary school grades, the higher the GPA in the engineering study. The students that achieved high grades in secondary school can generally attain better GPA during the engineering study. To achieve a minimum GPA of 2, students with secondary school grade of at least 80% should be admitted. Lower secondary grades can lead to a lower average GPA in the engineering study.

This improved GPA of the students is almost in a straight line relation with their secondary school grades. It may be also noticed from the same figure that the average GPA of the students at graduation is slightly less than after four years of study, which is also less than after two years of study. This implies the slight deterioration of the students' performance during study. For example, at a secondary school grade of approximately 90%, the average GPA after two years was about 3.15, while after four years it became 2.9 and at graduation it was 2.8. This difference between the three GPAs becomes even less for smaller secondary school grades.

Figure 2 illustrates the relationship between the GPA during the engineering study with the secondary school grades for engineering department A. It also shows the GPA at the three different points of two years after college entry, four years after college entry and at graduation. The average GPA at each secondary grade is also shown in the figure. It may be seen that department A exhibits a similar trend as the whole college shown in figure 1, but with different slope or sequence. It may be seen also that increasing the secondary school grades leads to an increase in the average GPA after two years, four years and at graduation. The difference in this department is that the average GPA at graduation is slightly higher than that after four years, which is also higher than that after two years. It implies that the performance of the student is improving over time. However, this improvement is higher at low secondary school grades compared to that at high secondary school grades. This implies that students with less secondary school grades, although initially at less GPA, improve with time in the college more than students with higher secondary school grades.



**Figure 1:** Effect of secondary school grades on GPA history of all engineering departments.

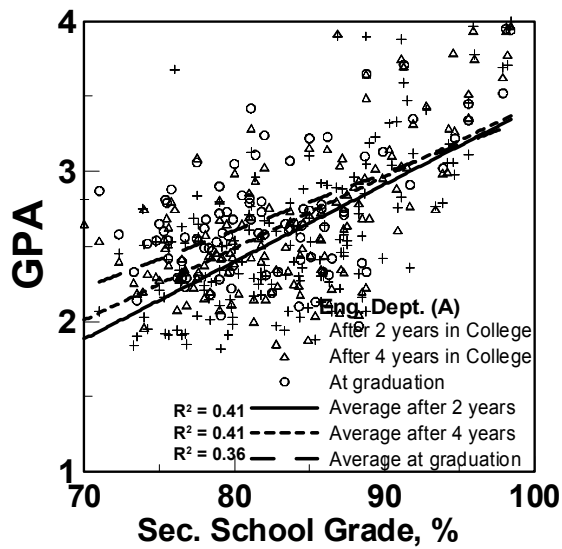


Figure 2: Effect of secondary school grade on GPA history of engineering department A.

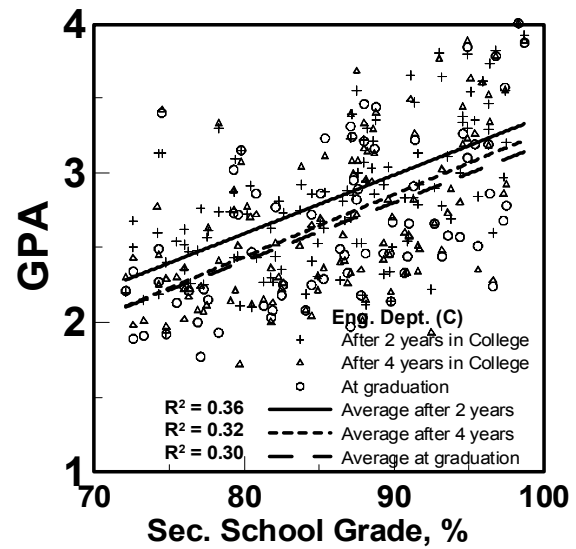


Figure 4: Effect of secondary school grade on GPA history of engineering department C.

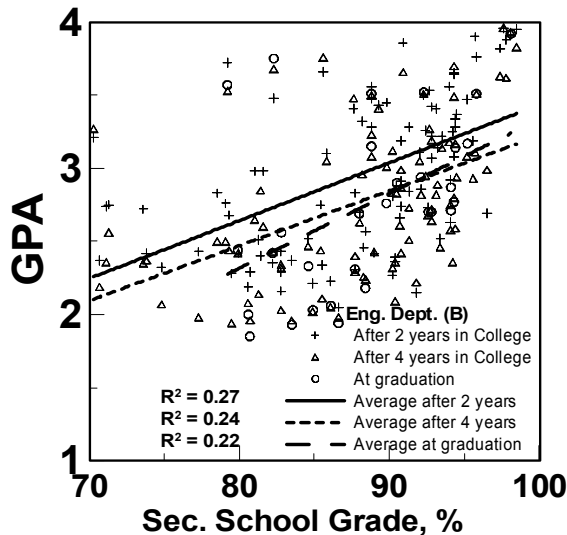


Figure 3: Effect of secondary school grade on GPA history of engineering department B.

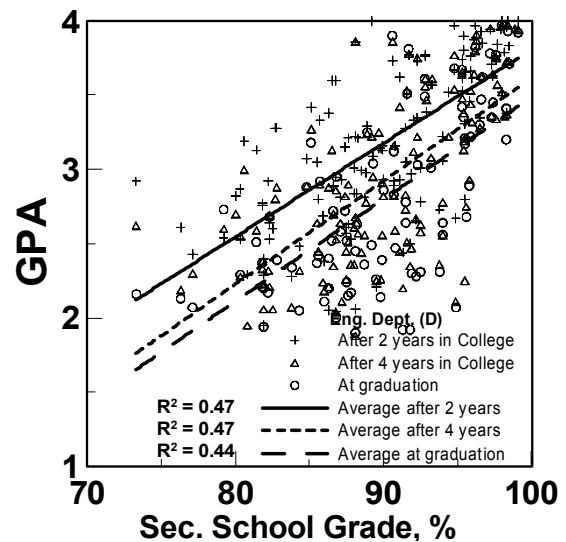


Figure 5: Effect of secondary school grade on GPA history of engineering department D.

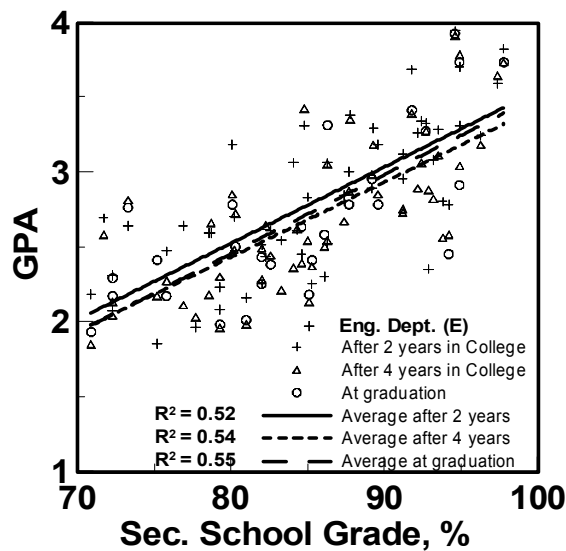
For department B, the relationship between GPA and their grades in secondary school may be seen in figure 3 for the same periods of time and averages. Generally the figure exhibits a similar trend as the rest of the departments, but with different values. It may be seen from the figure that the performance of students in department B deteriorates with time, as the GPA after four years becomes less than that after two years. Also for students with secondary school grades between 80-90%, the GPA at graduation becomes even less than that after four years. However, students with grades over 90% had slight improvement in GPA.

Figure 4 shows the performance of students in department C, which has a similar trend as departments A and B. However, for this department students' GPA become less and less over the years.

There is a drop in their GPA over the second two years, which is bigger than the last two years.

For department D, the performance may be seen in figure 5, which has a similar trend of the GPA increase with the secondary school grades. However, it may be also seen that the averages for the first two years is highest, followed by a drop in the GPA after two years, and followed by another drop in the GPA at graduation. This department exhibits a consistent drop of GPA over years, with no improvement in the students' performance.

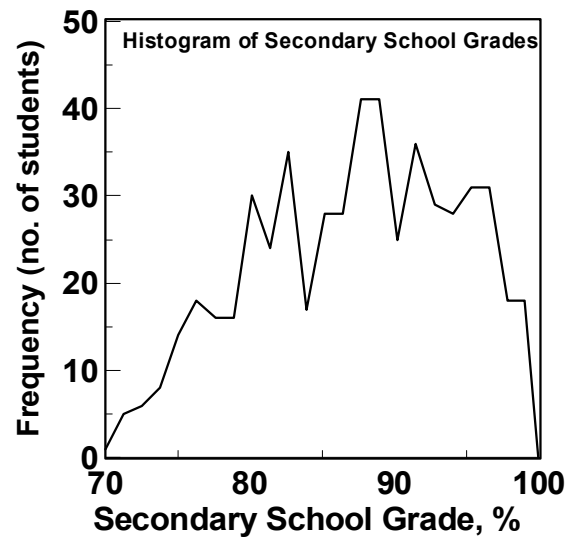
Figure 6 illustrates the performance of students in department E, with little drop in the average GPA from the first two years to the following two years. There is a slight improvement in the GPA at graduation, especially for students with high secondary school grades.



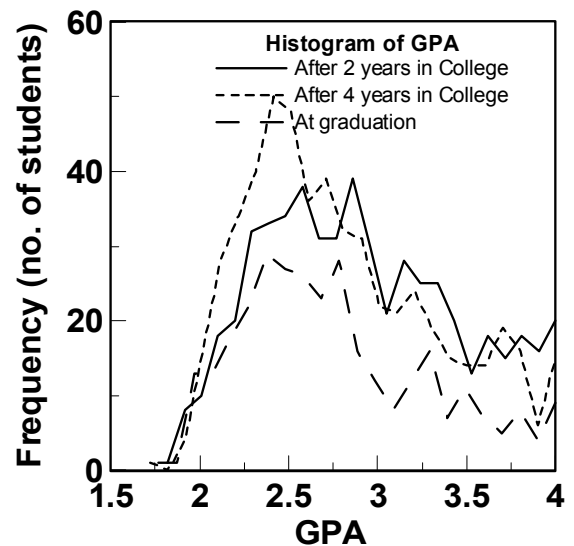
**Figure 6:** Effect of secondary school grade on GPA history of engineering department E.

It may be noticed that the performance of most departments is similar, with some deterioration of GPA over years, except one department (A) that exhibits some improvements over the years. This may be explained by the differences between technical departments, different assessment tools used and different nature of courses studied. Some programs like electrical and mechanical put more emphasis on mathematics and physics; hence this tends to reduce the GPA of students. Also the testing procedure may vary from one program to another, though the assessment tools are somewhat similar. Another reason for the drop in the GPA of the majority of students can be the difference between the assessment tools in the first year of study at the university (University General Requirement Unit), followed by one year at the college level (College Requirement Unit) just before students select a program. Different assessment tools can be the main reason for the drop in GPA. Students' assessment may be different when some faculty know that these students do not belong to their department, hence becomes more harsher.

It may be also noticed that in most of the programs (A through E) a significant scattering exists in the data of secondary school grades versus the GPA. Students with the same input school grades have different GPA at the same level. The scattering is clear from the low value of  $R^2$  for most average lines. As the  $R^2$  values are far from unity, then this means that the data is highly scattered. This high scattering may be also seen in the histograms shown in figures 7 and 8 for the grades and GPA, which give an indication to the high scattering. This scattering may be due to many reasons as the data collected is for males and females students with no distinction between them. It has been known for many years that the average GPA for females is much higher than that for males.



**Figure 7:** Histogram of secondary school grades for the 547 engineering students.



**Figure 8:** Histogram of GPA after two years, four years and at graduation for the 547 students.

This may have created the scattering in the overall data. Another reason for the scattering could be the significant differences in the schooling systems that exist in the UAE. Many students have graduated from school that follows the Emirates governmental system, while others graduated from non-Emirates systems, like the American or British systems. These three different systems vary considerably in the curriculum, assessment and students skills. Therefore, some students are shocked or tend to relax in the first two years (low GPA), while others will acquire themselves and increase their grades (high GPA). Also the crowd in the presented data (data after two years, after four years and at graduation) helps to present this scattering.

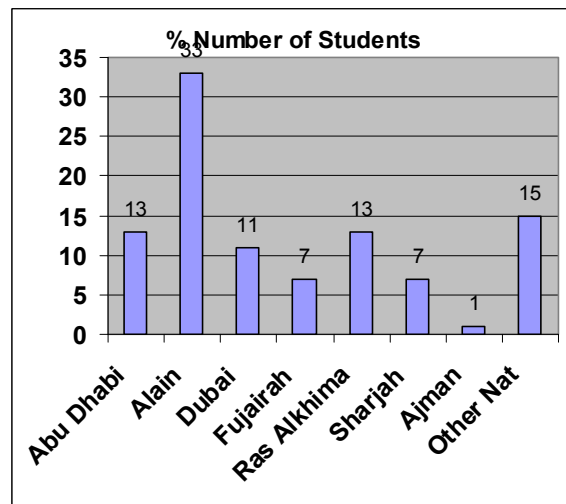
Figure 7 shows the histogram of secondary school grades for all students involved in this study. The majority of students have between 85-95% in

secondary school grades. A small number of students have less than 80% grades, which represent the older students who were admitted to the university before the year 2005. Figure 8 shows the histogram of GPA after two years of entry, after four years of entry and at graduation. This figure generally shows different trends. The first trend is for students with GPAs from 2 to 2.5, which shows an increase of the number of those students, followed by a drop in number of students at graduation. The second trend is for students with a GPA higher than 2.5. The trend is that their number becomes less after four years and even less at graduation. The majority of students lie between 2.25 and 3.25. It may be also seen that there are a small number of students that have a GPA of less than 2. These are the older students who were admitted to the university prior to the year 2000, as the university policy regarding the graduation requirements have been changed since the year 2006. The new policy states that students cannot graduate with a GPA less than 2, and they also receive an academic warning if their GPA reaches less than 2 at any stage of their study and eventually will not graduate if it reaches less than 2 at graduation.

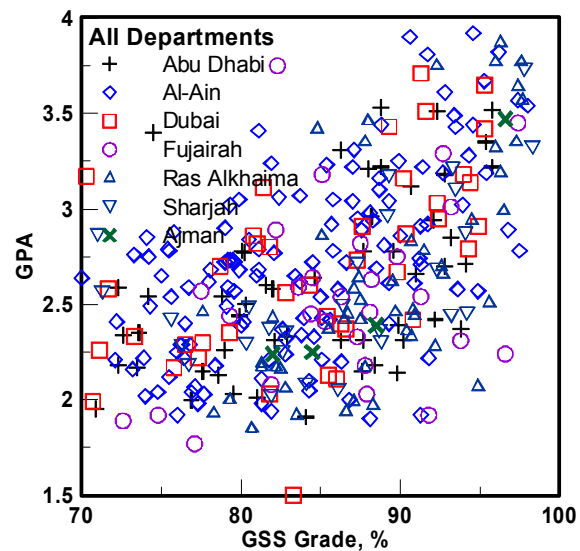
Table 3 also shows a summary of all figures with the minimum, maximum and average (over all students) given. It may be mentioned here that only older students were allowed to enter the college with secondary school grades less than 80% and graduate with GPA of 1.75 or higher. Newcomers to the college are only entered at grades of 80% or higher in secondary school and must graduate with GPA of 2 or higher.

**6 EFFECT OF SECONDARY SCHOOL LOCATION**

Figures 9 to 12 show the effect of location of secondary school on the performance of students. Seven states (or Emirates) of the country have been identified for the engineering students. They are namely Abu Dhabi (the capital), Al-Ain, Dubai, Fujairah, Ras Alkhaima, Sharjah and Ajman. These locations are also compared to non-national students from other countries, but received their final year secondary education in the country. As may be seen in figure 9, the majority of 33% of engineering students come from the Al-Ain city, where UAE University is located, where non-nationals are 15% of the total number of 547 students. It may be also apparent from



**Figure 9:** Percentage number of students from different Emirates.



**Figure 10:** Effect of secondary school grades on GPA at training (per Emirate).

figure 10 that for the whole college, there may be a trend (as mentioned above) that increasing the GSS grade improves the GPA performance. However, for individual Emirates, like Fujairah, this trend is not applicable. Also it may be apparent that the slope of the relation varies from one Emirate to another. Figure 11 and 12 show the minimum and maximum GSS grade and GPA, respectively. It may be seen that Sharjah has the highest maximum GSS grade, however, it does not have the highest GPA. Also Ajman has the highest minimum GSS grade,

**Table 3:** Minimum, maximum and average of secondary school grades and GPA history.

	Secondary school grades (%)	GPA after two years in university	GPA after four years in university	GPA at graduation
Minimum	70 (older students)	1.82	1.72	1.77 (older students)
Maximum	99.1	4	4	4
Average	86.64	2.87	2.765	2.72

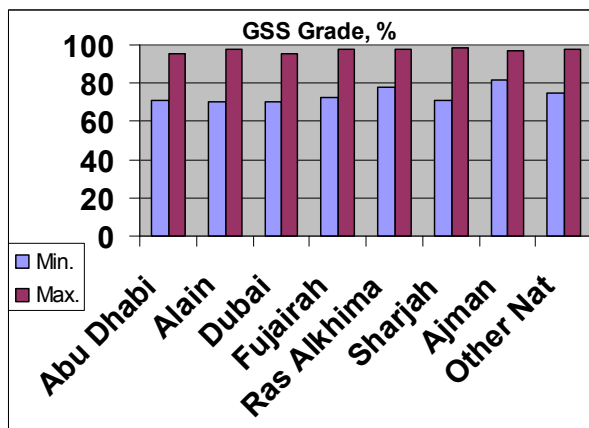


Figure 11: Minimum and maximum secondary school grades (per Emirate).

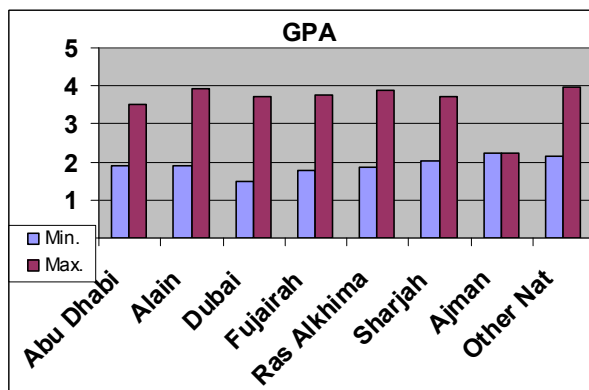


Figure 12: Minimum and maximum GPA at training (per Emirate).

however, it does not have the lowest GPA. This implies that the trend mentioned above does not necessarily apply on each individual Emirate.

One common criterion is shared between students that finished Emirates secondary education, that being the assessment tools used during their secondary education. All students finished their secondary school before 2007 used to have their grades calculated based on the final exam only; this has changed from 2007 onward to be 50% based on final exam and 50% based on the year-long work. The students' work included many items such as quizzes, progress exams, mid-term exam, term projects and presentation. All students entered this study are pre-2007, which followed the older system. The old system used is different than the multiple-choice exams of CEPA and the UAE University course exams.

## 7 CONCLUSIONS

From the case study presented here for the students at the UAE University, College of Engineering, the following conclusions may be drawn:

- The secondary school grades almost correlate with the GPA of students. Students with low secondary school grades generally have lower GPAs than

students with higher grades. For the engineering programs to improve the GPA of students, the minimum admission level of secondary school has to be increased.

- The majority of students in the College of Engineering have a GPA between 2.25 and 3.25. Female students generally have higher GPAs than the male students, due to natural and lifestyle differences. The admission of different nationalities would also improve the performance of students.
- The average GPA of the engineering students reduces with time from entry to the college to graduation. Individual departments exhibit a similar relation between secondary school grades and GPA, with some variation according to individual departments' nature of study, the math contents and assessment used. Some departments exhibit an improvement of their students' GPA, while others exhibit deterioration with time.
- The university performed some changes to improve the performance of the engineering students, like increasing the minimum admission level for secondary school grades, changing the course grade point value and increasing minimum GPA at graduation.

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