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Gender and Campus Based Comparative Study of Students Performance at the Faculty of Computing and Information Technology of King Abdulaziz University

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Abstract. The analysis of data has become an important part in how educators assess the overall performance of their students. It is a critical task and helps everyone involved to understand various attributes of the students' academic performance at their place of study. In this work, we critically analyze the performance of the students at the Faculty of Computing and Information Technology (FCIT) from various viewpoints. We include the students in the Boys Main Campus (BMC), Girls Main Campus (GMC), and Girls Faisaliyah Campus (GFC). For this purpose we use statistical methods as well as a machine learning algorithm. Our results show that the girls outperform the boys, and particularly, the GMC performed better overall than the GFC. This work helps shed light on similar trends in student performance, which can give further insight into various issues that affect the students' academic achievement levels, and as such, is helpful in FCIT's academic planning.

Keywords: Faculty of Computing and Information Technology (FCIT), King Abdulaziz University (KAU), Student Performance, Gender Analysis, Math and English Scores.

1. Introduction

Critical analysis of student academic performance plays a key role in academic policy making. Knowing when students performed best and worst can help the institution identify causes of that particular performance in that specific period, so that academicians can better learn about, and respond to, the factors that affect the students' performance. These factors can be any of several things, including new classroom

teaching techniques, the faculty's lack of experience, faculty teaching style, flaws in the time table, changes in courseware, and so on.

The contribution of this work is that it enhances our ability to understand what exactly affects the performance of students, as it gives a detailed description of three important factors:

- Gender (male and female)
- Quality (GPA out of 5 and grades)
- Time (academic year)

Student performance analysis is performed in almost every educational institution around the world in order to highlight the various aspects of their academic data. However, most of these reports remain for internal use only. In[1], a comprehensive analysis is performed on science and mathematics scores for students in countries including Turkey, China, Germany, Hong Kong, Brazil, Italy, Mexico, Poland, Tunisia, Portugal, etc. It was found that:

- Hong Kong-China, Shanghai-China, Singapore, Finland, and Japan are the top five performers in science in PISA 2012.
- Qatar, Poland, and Italy had a higher number of top performers from 2006-2012, and the same was true for Israel, Singapore and Estonia from 2009-2012.
- Countries like Italy, Brazil, Portugal, Mexico, Poland, Tunisia, and Turkey show a constant improvement in mathematics scores overall.
- The performance of boys compared to that of girl is almost similar in all countries and time periods[1].

Further, a few studies relate student performance to other elements. In[2], authors critically analyzed two potential mechanisms of this association:

(1) Cognitive competence perception of a student.
(2) The importance of the student-teacher relationship.

The results show that for cognitive competence, a student is largely dependent on the parent-child relationship which can enhance or decrease the student's performance. The study also finds that the student-teacher

relationship plays a critical role and that child-parent and student-teacher relationships are interdependent. Similarly, in work[3], student mathematics scores are analyzed. The critical analysis revealed that there are four major factors, which together affect student performance in Malaysia:

(1) Interest.
(2) Peers.
(3) The role of the teacher.
(4) The attitude of students.

Works[2] and[3] establish the fact that the teacher's role in student overall development is critical.

Parents' involvement in child education is always associated with changes in the academic performance of the student. Students whose parents are more engaged in their academic lives significantly perform better than those whose parents are engaged to a lesser degree[4-6]. In the latter case, the student's lack of proper understanding of basic mathematical principles can result in reduced problem solving ability in various technical subjects such as computer science, chemistry, physics, engineering, and other important areas where mathematical principles are applied. Also, reasoning abilities are affected by lower mathematical performance[7].

In addition to the above, the difficulties in mathematics that students face are often due to the low quality of teaching. To improve the students' performance in mathematics, teachers must know the issues their students face, and must also be well trained in particular and relevant teaching skills, as well as being committed towards their educational objective[8].

According to[9], some critical factors that add to difficulties in the process of learning mathematics are:

(1) Mathematics is considered a disliked subject among students due to fear, perseverance and endurance needed, and other associated factors.
(2) Most of the mathematics curriculums in various teaching institutes failed to prove their relevance to real life scenarios and applications, leading to lack of interest from the students.

(3) Mathematics' teachers do not show much interest in the subject and do not help the students to the level of assistance they require.

In this work, we critically analyze the FCIT students' performance from various viewpoints. We include the students of BMC, GMC, and GFC. The paper is divided into four sections. In section 2 we discuss data gathering. In section 3 we represent results and findings. Finally, in section 4 we give the concluding remarks.

2. Data Gathering and Analysis Methods

Data analysis plays a critical part in acquiring quality information from a dataset. Good data analysis also improves the decision-making process for educators and academicians in general. In this work we critically analyze a dataset which consists of 4111 records of the students from three campuses which are: BMC, GMC, and GFC, going from the period of 2009-2014 in the FCIT database, KAU. The dataset contains records in the following order:

- 165 records for 2009
- 296 records for 2010
- 432 records for 2011
- 406 records for 2012
- 2203 records for 2013
- 609 records for 2014

The attributes of this dataset are student ID, name, GPA, grades, subject, year, and subject code. The provided dataset contains the GPA of graduated and current students. It also contains grades from English (ELI 104) and Math (MATH 110); both courses are taken by the students in their first year of enrollment. The student dataset consists of seven attributes without duplicate entries.

For our analysis, we used popular statistical methods like mean (average) and standard deviation[10]. Further, we used an unsupervised learning algorithm for clustering, known as the *k*-means clustering algorithm. This is a popular method for cluster analysis in data mining, which helped us identify specific groups of students with specific properties[11].

In the next section, to help explain the outcome of our data analysis process, we visualize the results in the form of bar graphs, line charts, and other graphs.

3. Results and Findings

3.1 Average GPA of all Boy and Girls for all campuses

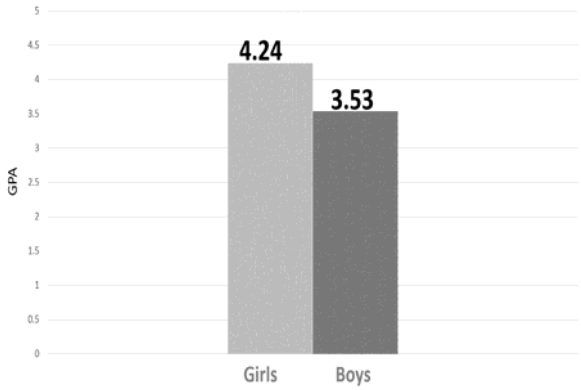

Fig. 1. Average GPA of all Boys and Girls for all campuses.

Figure 1 shows a bar graph of average GPA for all the students, boys and girls, in all campuses. The average GPA for girls is 4.24 while for boys it is 3.53. The girls' GPA is 0.71 points higher than that of the boys, which clearly shows that the overall performance of girls is better.

3.2 Standard Deviation of GPA for all Boys and Girls for all campuses

The standard deviation is a statistical evaluation method used to quantify the amount of variation in a dataset. Low variation, or a standard deviation close to 0, indicates that the data points tend to be very close to the mean, or average, of the set, while a high standard deviation indicates that the data points are spread out over a wider range of values[10].

In figure 2, we show the standard deviation (SD) in the FCIT boys and girls datasets. Here we can clearly see that the Girls SD is lower than the Boys SD, which means that the girls' scores are concentrated near each other. The Boys SD is 0.109 higher than that of the girls, which indicates that the boys' GPA is more dispersed or spread out. Overall, this means that, as a group, the girls score better than the boys

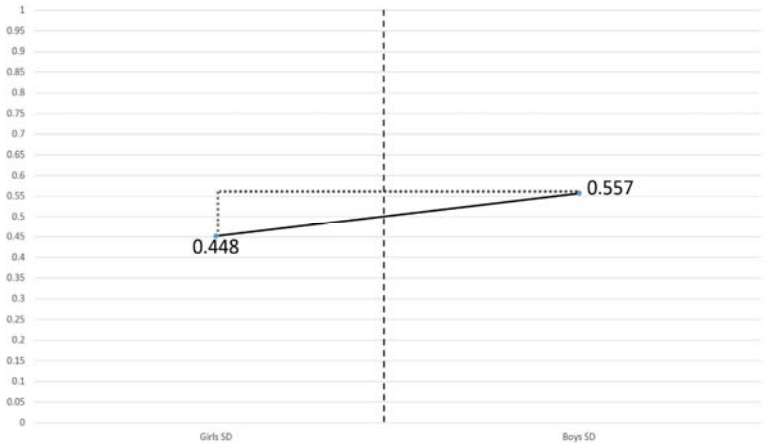

Fig. 2. Standard Deviation of GPA for all Boys and Girls for all campuses.

3.3 Year-Wise All Boys and Girls Average GPA

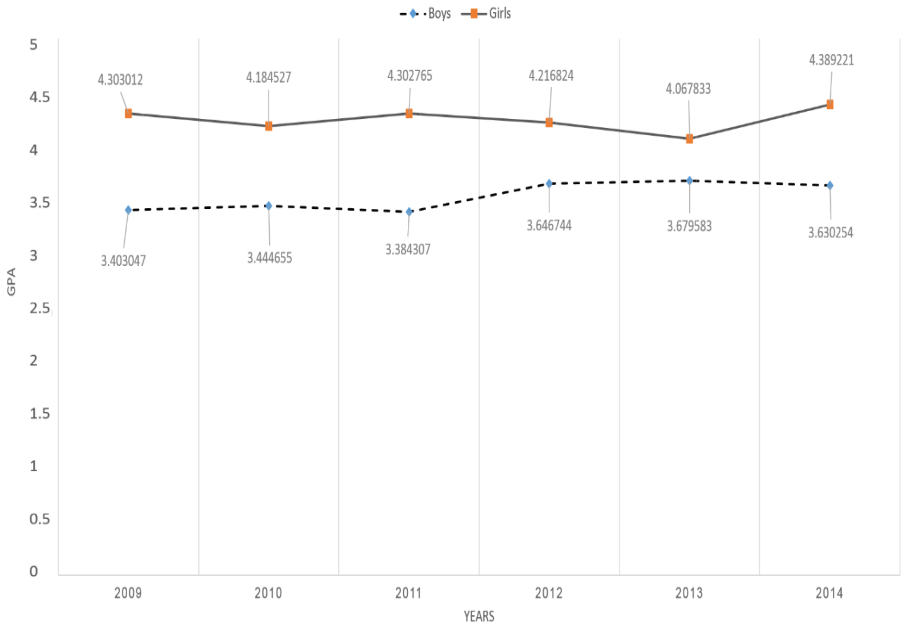

Fig. 3. Year-Wise All Boys and Girls Average GPA.

In figure 3 above, we show the annual average GPA for all boys and girls. The girls' best performance was in the year 2014, and their lowest was in 2013. However, annual GPA trends for girls are quite steady and do not show a lot of fluctuation. The performance of the boys is best in the year 2013 and lowest in 2011. However, annual GPA trends for boys

are always lower than the girls. Furthermore, the annual GPA of boys is always below four. Our conclusion in this analysis segment is in line with the rest of the study, as it shows that girls performed better than the boys.

3.4 Cluster Analysis of Boys with GPA

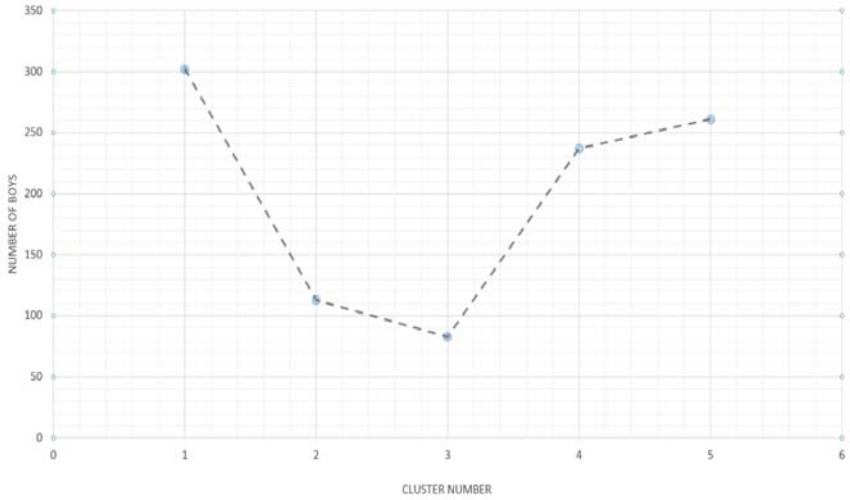

Fig. 4. Cluster Analysis of Boys with GPA.

Table 1. Cluster-wise details.

Cluster Number	Number of Boys	GPA
One	302	3.564
Two	113	2.555
Three	83	4.591
Four	273	3.129
Five	261	3.947

For figure 4, we completed a cluster analysis of the scores for boys. Clustering is used in order to divide the boys into various groups based on their GPAs. This allowed us to see which GPA groups the boys most belong to. The results of figure 4 also appear in tabular format in Table 3. According to Table 1, only 8.04% of boys had a GPA higher than 4.0, which is significantly lower than what the girls achieved. In fact, there is a considerably higher number of boys with GPA lower than 4.0 than there are girls in the same category.

Additionally, the lowest GPA cluster among the boys (cluster two) has a 2.55 GPA. This is far lesser than the lowest cluster for girls, who scored a 3.18 GPA as we show in the next section. The boys in the highest scoring cluster in the above table (cluster three) have GPAs of 4.59, whereas according to Table 2 below, the girls' highest GPA cluster (cluster 5) has a GPA of 4.78. This means that the highest GPA cluster for girls is greater by 0.19 points than the highest GPA cluster for boys. This analysis shows that the girls' academic performance is consistently better than that of the boys.

3.5 Cluster Analysis of Girls with GPA

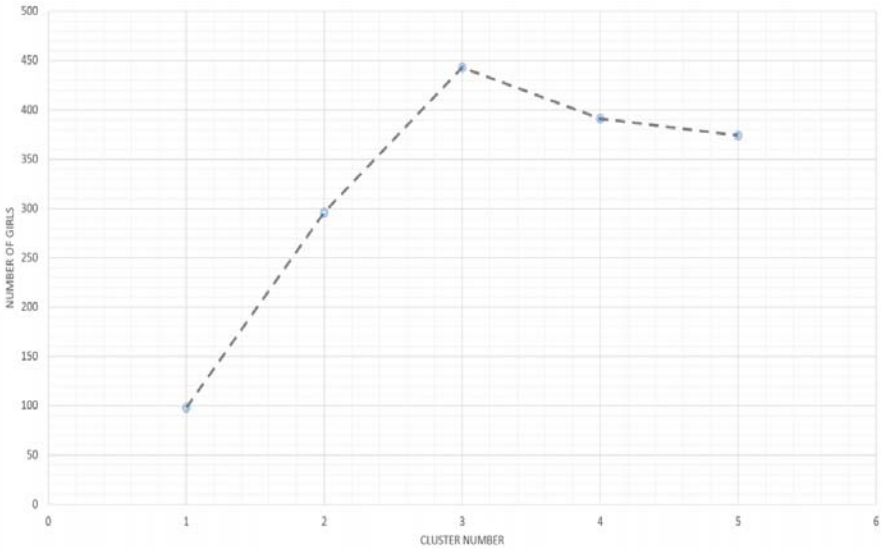

Fig. 5. Cluster Analysis of Girls with GPA.

Table 2. Cluster-wise details.

Cluster Number	Number of Girls	GPA
One	98	3.185
Two	296	3.781
Three	443	4.436
Four	391	4.124
Five	374	4.785

In figure 5, we show the results of a cluster analysis of the girls in our dataset. This clustering divided the girls into various groups based on their GPA. It allowed us to see in which GPA groups most of the girls belonged. The results of figure 5 are summarized in Table 2 for easier reading. According to Table 2, 75.28% of girls are in clusters which

scored a GPA higher than 4.0. In other words, there is a significant and considerably higher number of girls with a GPA higher than 4.0 then there is among the boys.

Also, no cluster of girls had a GPA less than 3.0, which is not the case with boys. 24.72% of girls had a GPA below 4.0, whereas 91.92% of boys had a GPA below 4.0. The results here show that the maximum number of boys get low GPAs where, in the opposite direction, the maximum number of girls are getting high GPAs. Therefore, the girl's overall academic performance is better.

3.6 Average grades of all boys and girls in Math and English

In figure 6, we show a comparative analysis of the Math and English average grades for boys and girls. Figure 6 differentiates between girls and boys, respectively. The performance of both genders is close in English, though girls are slightly ahead. In Math, however, girls outperform boys to a larger degree. The average Math grades for girls are higher by 11.28 points than the average grades of boys. Overall, girls performed better than boys, particularly in mathematics.

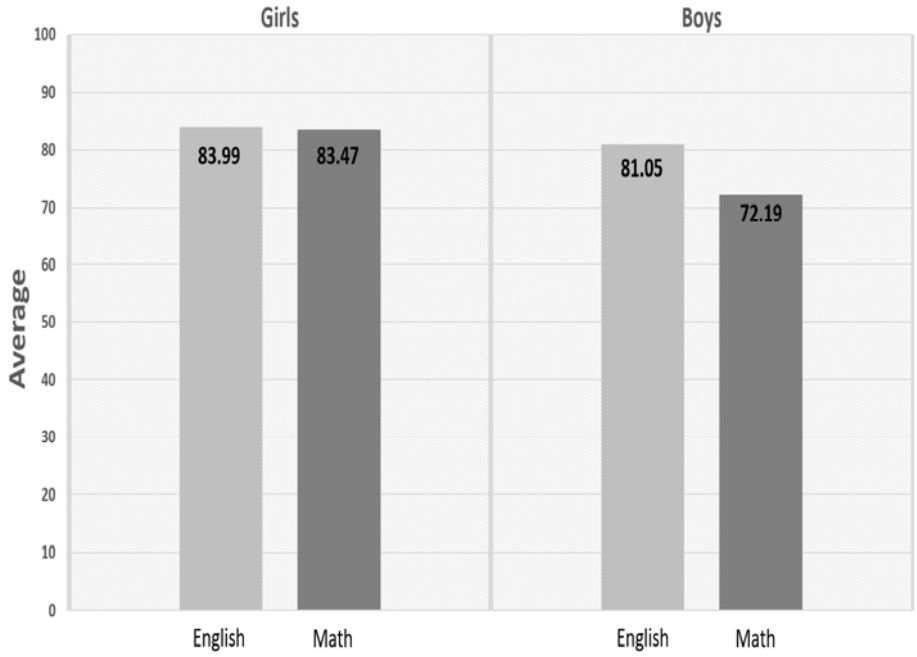

Fig. 6. Average of grades of all boys and girls in Math and English.

3.7 Campus-wise and course-wise average grades of boys and girls

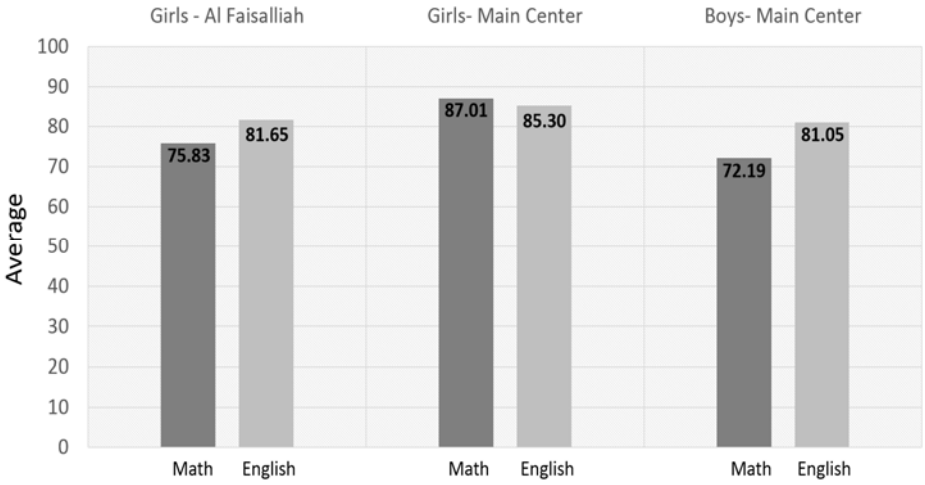

Fig. 7. Campus-wise and course-wise average of grades of boys and girls BMC, GMC and GFC.

In bar graph 7, we show a comparative analysis in terms of campus and course average grades for both boys and girls. The graph reveals that GMC has the best grades overall. The average grades of BMC and GFC in English are almost the same, though GFC performed slightly better in mathematics.

3.8 All boys and girls year-wise & course-wise grades

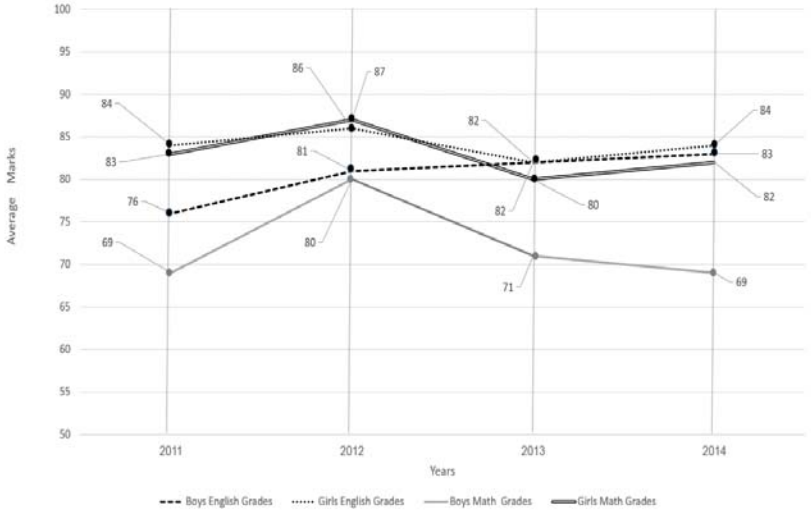

Fig. 8. All boys and girls year-wise & course-wise grades.

In figure 8, we draw a line chart that shows annual grades, as well as specific course grades for boys and girls. Year 2012 is the best academic performance year for both boys and girls, provided we exclude the boys' English grades. Year 2013 was when the girls had their lowest grades, and the same was true in 2011 for the boys.

3.9 Campus-wise and year-wise average grades

In figure 9, we show the average grades for all the students in the three campuses, across the time period from 2011-2014. If the boys' English grades are excluded, then 2012 is the best academic performance year for all campuses. However, the boys need to improve their grades to lower the grade differences between themselves and the girls.

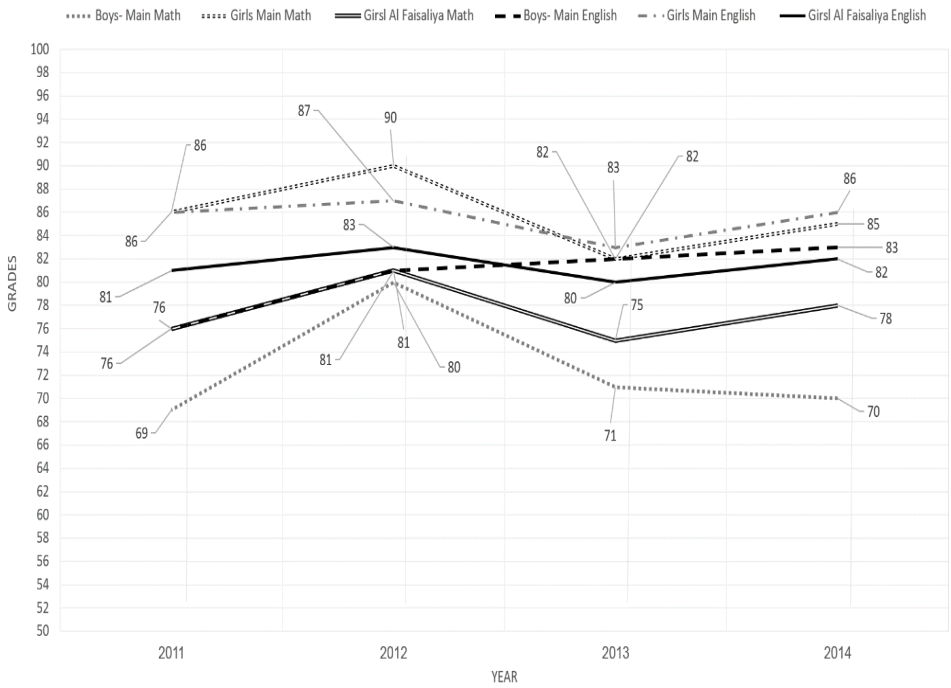

Fig. 9. Campus-wise and year-wise average grades.

Note that question of why the girl's overall academic performance is higher especially at the main campus is beyond the scope of this paper. Many factors influence this phenomena academically and socially.

3.10 Correlation between GPAs and grades of Math and English

A correlation helps to see how strong or weak a relationship is between two variables. However, it does not reveal the nature of the relationship. When the variables Grades and GPA correlate, it does not necessarily indicate that a change in one variable effects a change in another variable[12].

A very important question arises in this study *i.e.* does the performance of students in mathematics and English effect their overall GPAs? The correlation coefficient between students' grades in mathematics and their GPAs is 0.622667 and the correlation coefficient between grades in English and GPAs is 0.3568789. With the help of Table 3, this can be interpreted as a strong effect of grades in mathematics on students' overall GPAs. However, the effect of grades in English on the overall GPAs of the students is weak.

Table 3. Interpretation of strength of correlation results.

Coefficient Range	Strength of Correlation
0.00 – 0.30	Weak
0.31 – 0.50	Moderate
0.51 – 0.80	Strong
0.80 – 1.00	Very Strong

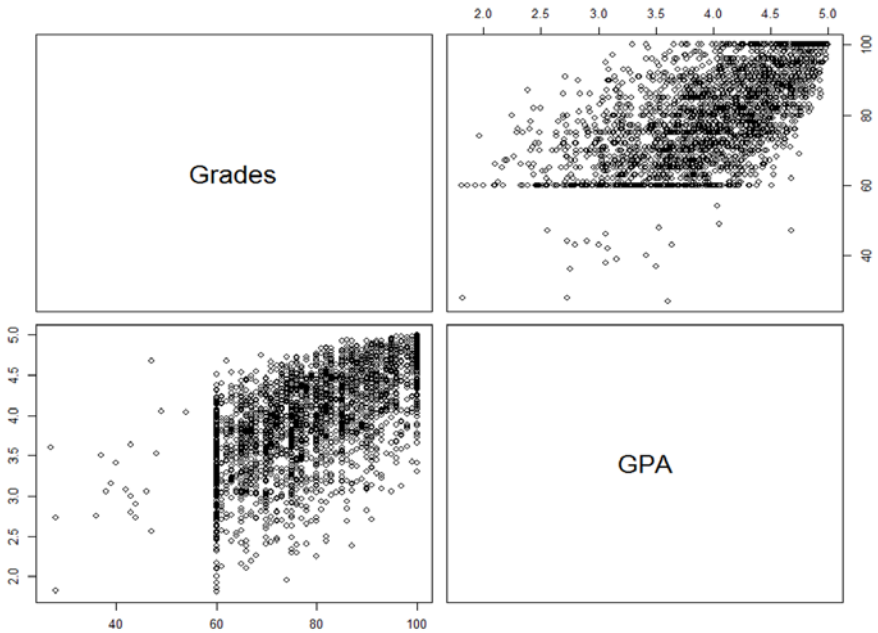

Fig. 10. Scatterplot Matrix for Grades of students in Math and GPA.

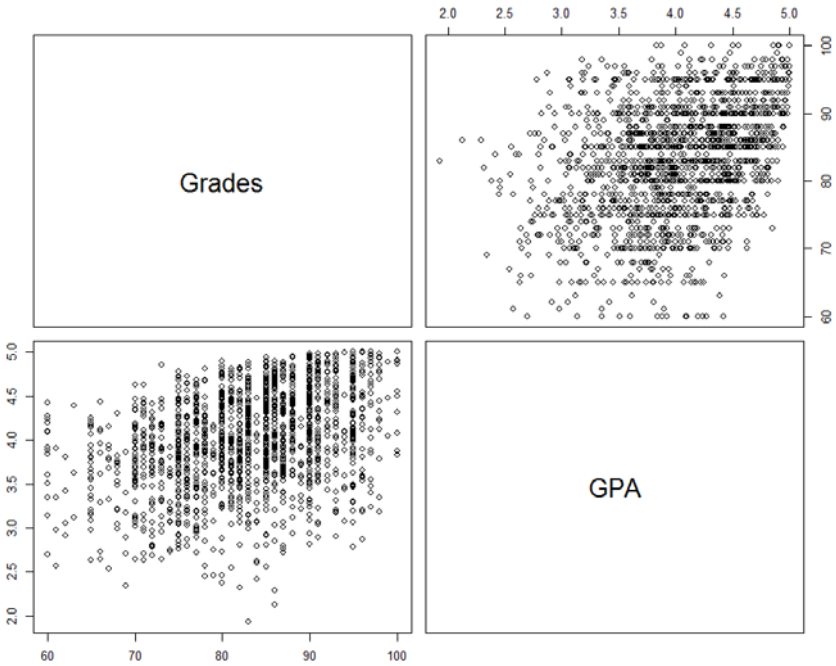

Fig. 11. Scatterplot Matrix for Grades of students in English and GPA.

We present correlation analysis results graphically in figs. 10 and 11. We observe that students with high grades in mathematics tend to have high GPAs. However, students who are performing well in English do not necessarily have high GPAs.

4. Conclusion

This study is based on examining three critical aspects of student performance analysis, which are:

- Gender (male and female)
- Quality (GPA and grades)
- Time (the academic year)

By using statistical methods like mean and standard deviation, we tried to identify various performance aspects that affected the students. Further, we used *k*-means clustering to group the students based on similar properties in their academic performance. After completing our data analysis, we created various graphs to aid in visualizing the results. After data analysis and visualization, we came up with the fact that girls outperformed the boys in our dataset.

Overall, we find that there is a significant gap between the performance of boys and girls. Furthermore, we established that boys need to improve their grades and GPA so that they can narrow the gap between their own academic performance and the girls. One interesting finding is that among girls, the GMC outperformed the GFC.

This work is the first step towards further improving the academic performance of students. The next step for FCIT academicians is to find the reasons for the high or low GPAs and grades of the student with respect to campus, course, and year. We look forward to analyzing richer data with more attributes to find relevant and interesting facts.

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دراسة مقارنة بين أداء طلبة كلية الحاسبات وتقنية المعلومات بجامعة الملك عبدالعزيز استنادًا إلى الجنس وفرع الكلية

إياد عدنان كاتب

أستاذ مساعد، قسم علوم الحاسبات، كلية علوم الحاسبات وتقنية المعلومات، جامعة الملك عبدالعزيز، جدة، المملكة العربية السعودية

المستخلص. تحليل البيانات أصبح جزءً مهمًا لتقويم الأكاديميين لأداء طلابهم. فهو يساعد المسؤولين على فهم اختلاف الأداء الأكاديمي لدى الطلاب في مكان دراستهم. في هذا البحث، نقوم بتحليل نقدي لأداء الطلاب في كلية الحاسبات وتقنية المعلومات بجامعة الملك عبدالعزيز من زوايا مختلفة، حيث ندرج في هذه الدراسة طلاب وطالبات المركز الرئيس، بالإضافة إلى طالبات فرع الفيصلية، باستخدام الأساليب الإحصائية وكذلك خوارزمية تعلم الآلة. وتظهر نتائجنا أن الفتيات يتفوقن على الأولاد، وعلى وجه الخصوص أداء طالبات المركز الرئيس أفضل بشكل عام من أداء طالبات فرع الفيصلية. ويساعد هذا العمل على تسليط الضوء على اتجاهات مماثلة في أداء الطلاب، مما يمكن أن تعطي مزيدًا من التبصر في مختلف القضايا التي تؤثر على مستويات التحصيل الدراسي لدى الطلاب والطالبات، مما يفيد كثيرًا في التخطيط الأكاديمي للكلية.