Correlating entrance data and first year academic performance of students enrolled in the Integrated Master in Mechanical Engineering (MIEM) at FEUP

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Introduction

In Portugal, admission to public higher education (PHE) is subject to quantitative limitations, resulting from the number of places (*numerus clausus*) fixed annually by PHE institutions for each cycle of studies (CS). For each institution/CS pair, applicants to PHE institutions are ordered by their application mark, *ApM*. The weight $k \in [0, 1]$, the national exams compulsory to calculate *S* and the minimum marks required for *ApM* and *E* are decided by the PHE institution/CS pair. For Mechanical Engineering Integrated Master CS, all Portuguese Universities require the national exams of "Mathematics A" (*M*) and "Physics and Chemistry" (*PQ*), where $M, PQ \in [0, 200]$.

$$ApM = k.S + (1\text{-}k).E \qquad E = 0.5\,(M + PQ)$$

S - Achievements at secondary school for a period of three years
E - National exams grade

In the last years the students' *ApM* for the Integrated Master in Mechanical Engineering (MIEM) at Faculty of Engineering University of Porto (FEUP) have been the highest among all Mechanical Engineering CS (Figure 1, values for 2019/2020). This is due to the high quality of training provided by FEUP, which translates into high competence and know-how acquired by MIEM graduates, put at the service of employers.

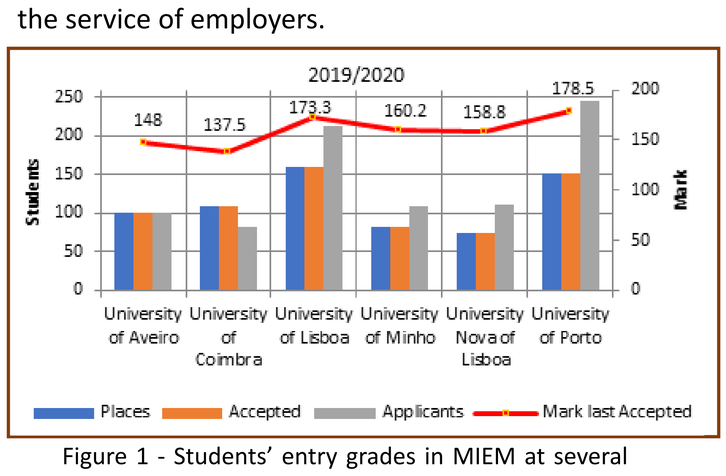

Figure 1 - Students' entry grades in MIEM at several Portuguese universities in 2019/2020 .

However, students' academic performance, defined as the performance outcomes that show the extent to which a student has accomplished specific goals in instructional environment once enrolled in MIEM, does not always translate into high success and good results at the end of the first year in FEUP. Several factors can contribute to this:

- Some students choose another CS as their first option (with higher entry grade), which may be a cause of frustration with negative impact on students' academic performance;
- The geographic origin of the students is not uniform. Most entering MIEM are from Porto metropolitan area, but many have to move to Porto and adapt to a new reality in the city, away from home, which often has consequences at the academic level;
- The type of teaching/learning methods practiced in private/public secondary schools, which is excessively focused on obtaining good marks in the exams for accessing university are quite different from those the students found later at university, requiring an adaptation period with, sometimes, negative consequences.

This study investigates the relationship between students' *ApM* and first year performance, for different groups structured by, gender (Female/Male), type of secondary school (Public/Private), living place (Away/Home) and application option (Option 1/Option 2-6) at MIEM in the academic years 2016/17, 2017/18, 2018/19 and 2019/20.

Results and Discussion

1. Characterization of the Students at Entrance

The students enrolled in MIEM are predominantly male. Most come from public schools and live in the metropolitan area of Porto. Despite the majority chooses MIEM as first option, there is a considerable portion who would prefer other CS (Figure 2, left panel). These data are similar in the 4 years under analysis.

For the period of analysis 2016/17 – 2019/20, the distributions of *ApM* of the 8 groups of students considered are identical, with the exception of the group Option 2-6. In fact, it can be verified that the students that choose MIEM in option 2 up to 6 do not have top *ApM* (Figure 2, right panels).

This characteristic is regular during the 4 years in analysis, with just small variations. Several actions have been carried out by the CS responsibles to mitigate this issue.

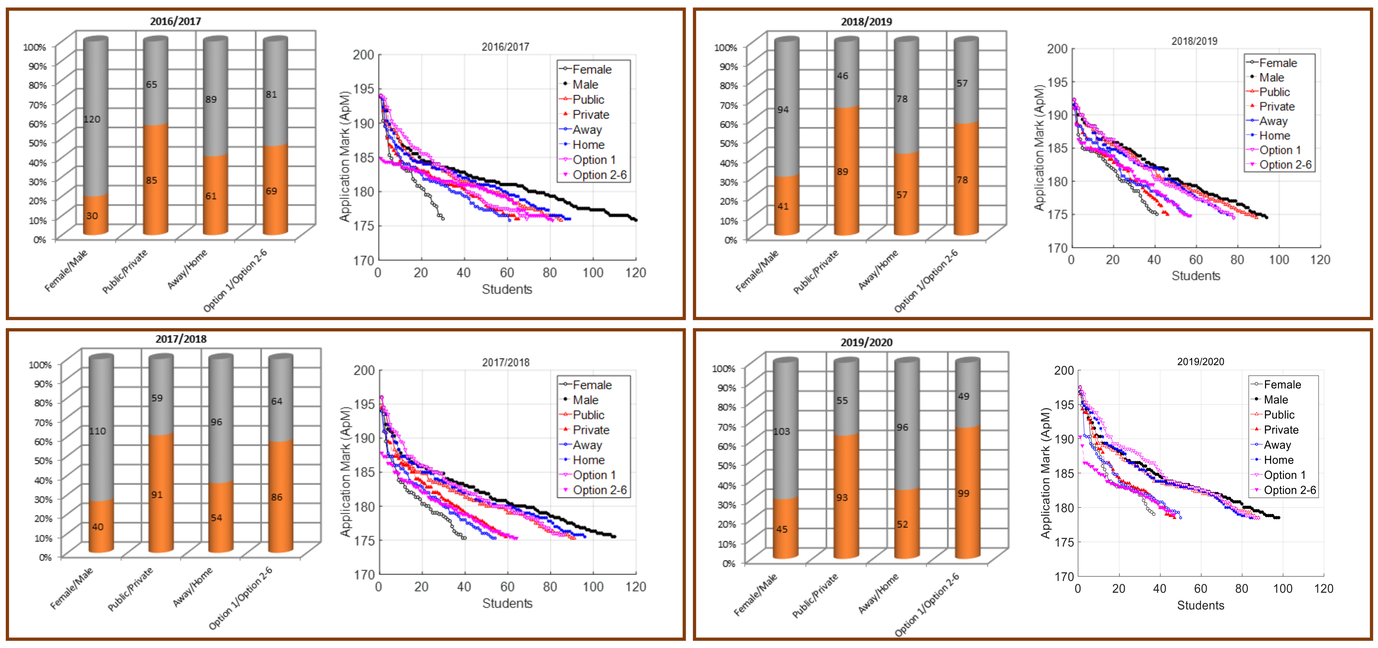

Figure 2 – Characterization of the students at entrance: Female/Male, Public/Private, Away/Home and Option 1/Option 2-6 in 2016/2017, 2017/2018, 2018/2019 and 2019/2020.

2. Characterization of the Students at the end of First Year

To characterize the students' performance at the end of the first year, the *Y1M* metric is defined:

$$Y1M = A.N$$

A - Official mean calculated by FEUP's Academic Services (10 - 20)
N - Number of curricular units passed (0 - 10)

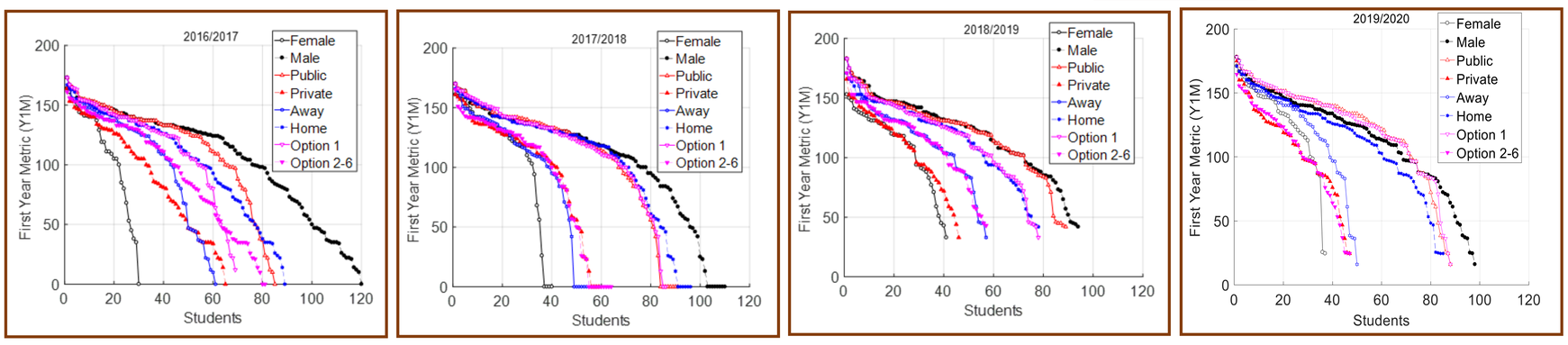

Figure 3 – Characterization of the students at the end of first year: Female/Male, Public/Private, Away/Home and Option 1/Option 2-6 in 2016/2017, 2017/2018, 2018/2019 and 2019/2020.

For the period 2016/17 - 2019/20, the distributions of *Y1M* of the 8 groups of students are identical (Figure 3), with an interesting pattern obtained for the group Option 2-6. In fact, despite entering in MIEM without top *ApM*, the students in this group do not reveal worse performance when compared with the others.

3. Correlation Between the Students' *ApM* and *Y1M*

The Pearson correlation is calculated between *ApM* and *Y1M*:

$$\rho = \frac{\sum_{m=1}^{M}\left[ApM(m) - \mu(ApM)\right]\cdot\left[Y1M(m) - \mu(Y1M)\right]}{\sqrt{\sum_{m=1}^{M}\left[ApM(m) - \mu(ApM)\right]^2}\cdot\sqrt{\sum_{m=1}^{M}\left[Y1M(m) - \mu(Y1M)\right]^2}}$$

M - Number of students
$\mu(\bullet)$ - Arithmetic mean

For the period 2016/17 - 2019/20, the correlations are small, independently of the group of students considered. This means that students' may exhibit good or bad results at the end of first year in MIEM, independently of their application mark and of their gender, type of secondary school (Public/Private), living place (Away/Home) and application option (Option 1/Option 2-6) to MIEM.

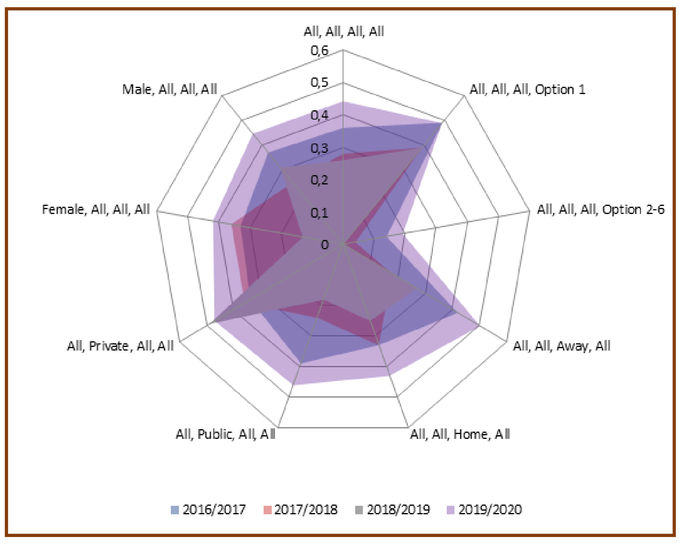

Figure 4 depicts the Pearson correlation, showing significant variation over the 6-year period of analysis. However, no special pattern can be identified, with exception of that exhibited by the group Option 2-6. For this group the correlation between *ApM* and *Y1M* is clearly smaller that the values obtained for the other groups, meaning that despite not having top *ApM*, the students of this group are capable of achieving results as good as their colleagues.

Figure 4 - Pearson correlation between *ApM* and *Y1M for the groups* Female/Male, Public/Private, Away/Home and Option 1/Option 2-6 in 2016/2017, 2017/2018, 2018/2019 and 2019/2020.

Conclusions

In this work the relationship between students' *ApM* and first year performance index *Y1M* was investigated. Different groups of students were considered during a 6-year period. The analysis revealed small correlations between *ApM* and *Y1M*, meaning that all students exhibit good or bad results at the end of first year in MIEM, independently of their application mark and of their gender, type of secondary school (Public/Private), living place (Away/Home) and application option (Option 1/Option 2-6) to MIEM. A surprising pattern was obtained for the group Option 2-6, since it was observed that, despite entering in MIEM without top *ApM*, the students in this group do not reveal worse performance than the others.

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