

RETENTION IN SECOND YEAR COMPUTING STUDENTS IN A LONDON-BASED UNIVERSITY DURING THE POST-COVID-19 ERA USING LEARNED OPTIMISM AS A LENS: A STATISTICAL ANALYSIS IN R

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Abstract. The aim of the current research project is to investigate the low retention rate in second year undergraduate computing students at a London based university. The research is conducted during the post-Covid-19 era using learned optimism as a lens. The main aim is to support the university's efforts to improve retention rate as the overall dropout has been increasing in the last few years. The research methodology employed was an exploratory investigation approach by using statistical modelling analysis in R to predict behavioural patterns. The study aimed to discover any effect the CODE-It initiative had on student grades and optimism scores, to quantify its success as an initiative. The main outcome of the data analysis is that the CODE-It initiative positively affected student optimism score, especially black ethnicity students. Furthermore, a slight increase in the least optimistic students was observed. Returning to in person interaction with classmates and lecturers could be a major factor in reducing the minimum score compared to the previous year's study (2021). However, there is still a very real post pandemic effect being experienced by many students, especially around matters of hardship and finance. Finally, for those students who did attend CODE-It, 85% showed that they felt it was a worthwhile exercise. Specifically, black ethnicity students had a higher proportion of attendance and were no longer the student ethnicity group with the lowest optimism score.

Keywords: Learned Optimism, Student Retention, Computing, R Programming, Quantitative Research, Data Analysis.

1 Introduction

In 2021 the authors conducted research into the reasons for higher than usual dropout rates in foundation and first year undergraduate computing students at a London based university. To achieve this, a survey was conducted among those students to collect relevant data and then analyse it. This data was analysed using R, a statistical modelling language, to examine potential links between optimism levels and retention. The overall conclusion was that students with a foreign qualification were optimistic (comprising 31% of the students), while students with other or an unknown qualification were mildly pessimistic (comprising 43% of the students). Students with a Bachelor of Technology (BTECH), Higher Education diploma or A level qualification were generally more pessimistic (comprising 26% of the students), especially if they were also of black ethnicity (comprising 5%), or were also not of black ethnicity, aged under 34 and British (comprising 5% of the students).

To further identify factors affecting optimism the authors conducted a similar survey for the same group of students in 2022. Especially, the black ethnicity group who were identified with the lowest optimism scores and therefore at greatest risk of dropping out. Although the survey sections and questions remained the same a further section was included which asked the students if they had been involved in an initiative run by the university studied known as CODE-It. The study aimed to discover any effect the CODE-It initiative had on student grades and optimism scores, to be able to quantify its success as an initiative and finally make recommendations for a further study. CODE-It is a short programming training course aiming to prepare students to solve real world projects. Arranging students in teams of at least 3 and no more than 5, gives them an opportunity to be creative and innovative in solving real world problems on a single theme.

2 Literature Review

Non-continuation in UK universities has been an issue over the past several years. In 2019/2020 the percentage of both young and mature students leaving HE has reduced by 1.3% and 1.8% respectively from consistent yearly values (HESA, 2022). The figures are for UK students who did not leave within 50 days of commencement, not continuing

in HE after their first year of HE provider and academic year of entry. Similar data is seen for both Scotland and Wales for young students and Scotland for mature students, with a nominal increase in Wales. Overall, retention rates in England are good compared to international institutes. A rate of 72% of students in 2021 is significantly above the international average of 39% for bachelor's degrees (Hillman, 2021a). However, drop-out rates among young undergraduates have increased over the past fifteen years only reducing slightly in 2019/20 (HESA, 2022).

During recent research conducted by Keohane (2017) it was found that London has the highest drop-out rate of all English regions, and the capital struggles to keep students. Those universities with a higher intake of black ethnicity students are more likely to see students from disadvantaged backgrounds not complete their studies. However, more selective higher education institutions have lower non-continuation rates for black ethnicity students than white. Gender has also been seen to be a major factor in continuation rates. Only binary gender data is available currently, which shows that completion rates for female students are 11% higher than males. Furthermore, London universities have a high proportion of students from low socio-economic backgrounds and from ethnic minorities, which partly explains the higher-than-average drop-out rates seen within the region. However, at the same time, students attending London universities tend to come from areas with high university participation rates, and students from high university-participation rates typically have lower dropout rates (Priestley et al., 2022).

There seems to be no evidence that dropout rates are linked to the standing or academic success of an institute, as some universities with gold or silver awards have dropout rates much higher than the benchmark. Investigating the various demographics of those who dropped out, students who were deemed to be mature (an age of 21 or over is categorised as mature in the UK) were twice as likely to drop out of university than those students entering straight after A levels. Two main concepts were identified as factors which could explain the likelihood of a student continuing with their studies or dropping out, these being a sense of belonging and a level of engagement (Vytنيorgu, 2022).

In the most recent survey conducted by the Higher Education Policy Institute (HEPI) data reveals that the majority of White students – 61% – feel a positive sense of belonging, while for other student groups, the sense of belonging is significantly less evident: Asian: 48%; Black 46%; Chinese 46%; mixed: 53%; and Other 43% (HEPI, 2022). However, a new questionnaire on loneliness identified that higher education can be a lonely place, with nearly one-in-four feeling lonely 'all' or 'most' of the time (HEPI, 2022). It may not always be possible for a student to engage fully in university life in a way that would not affect them academically. Two reasons for this are financial and time constraints. One small study of institutions in London found that travel or commuting time stayed a significant predictor of student progression or continuation for England-domiciled full-time undergraduates at three of the six London institutions participating in the study (Hillman, 2021a). In the case of mature students, they may have been out of education for some time and might also have work and home life to balance.

This is all at a time when students in higher education are still feeling the aftereffects of the Covid pandemic. Especially involving factors around finance which may be a cause of concern for many students and a contributing factor to optimism scores. A recent finding revealed that the number of students asking for emergency cash nearly tripled between 2018-19 and 2020-21 at 95 UK universities, with 60% being successful in their application for funds (Shearing, 2022).

3 Methodology

Quantitative analysis involves the systematic analysis of data through collection and statistical, mathematical, and computational analysis to obtain results. Numerical data is used and analysed using special statistical techniques to get the solutions for the questions like how, how many, how much, what, where, when and who (Apuke, 2017). The quantitative data is then analysed and modelled using the R programming language in R studio. The purpose of preferring a quantitative approach is to create and implement statistical models, theories and hypotheses related to the subject of research. A quantitative approach is used to bring out a conclusive result for the objective.

The data collection method employed was a questionnaire in the form of a survey. The data collected through the survey was then explored to discover and summarize the characteristics of the data (see also Section 4). Then, an exploratory analysis on data was performed to summarise the characteristics of data. Specifically, regression tree analysis with the use of scatter and box plots to show how various aspects of the data relate to each other. In the current research, the outcome was the optimism score as the target variable and the predictive variables were split into two feature sets. The first feature set consisted of attendance of CODE-It, gender, age, ethnicity, disability, full or part-

time student and level of study. The second feature set consisted of attendance of CODE-It, gender, age, ethnicity, disability, full or part-time student, level of study and average component mark.

4 Data Collection

The data under analysis was collected in the form of an on-line survey from the computing students who participated in the previous study (2021). The survey was structured in the three following sections.

Section 1 Respondent Content. Consisting of seven questions, this section was concerned with making the student aware of the nature of the survey and seeking their permission to use the data in the research in line with the General Data Protection Regulation (GDPR).

Section 2 Optimism Questions. Adapted from the survey for “Learned Optimism” (Seligman, 2018) and consisting of 30 questions which were applied to the Optimism Test Scoring Sheet and the interpretation guide applied. From the survey data an overall score was obtained by using the Optimism Test Scoring Sheet values. Specifically:

- A student’s pessimism score when unpleasant events happen,
- Optimism score when good events happen,
- Total optimism score, and
- Hope score.

The pessimism score is a score when unpleasant events happen and is the total of questions answered with the I (5/30), D (5/30) or F (5/30) option. There was a maximum pessimism score of 15 available across the 30 questions on the questionnaire. The optimism score is a score when good events happen and was the total of questions answered with the H (5/30), E (5/30) or B (5/30) option. There was a maximum pessimism score of 15 available across the 30 questions on the questionnaire. Total optimism was the calculated score of optimism - pessimism.

Section 3 Final Question. A new addition to the current study’s survey involved asking the student if they participated in the CODE-It initiative and (if they did) whether it was a positive or negative experience for them.

As this was the second year of the study, and included participation in the CODE-It initiative, the results from this year’s survey (2022) were merged with the students’ current average component mark and previous year’s average module result (2021). This data merging happened because data from various sources are often merged for analysis so that multiple variables from diverse sources and domains can be compared.

5 Data Analysis and Discussion

After the data merging was completed, some transformations were made to aid analysis and some cases filtered out, either due to missing data or because student consent was not provided. From the original 74 cases, 7 cases did not give consent, leaving 67 cases which could be used for analysis.

The previous’ year study highlighted four recommendations for further analysis:

1. Contrast in optimism of students with foreign qualifications and UK qualifications,
2. Exploration of factors causing black ethnicity students to be less optimistic,
3. Expand the research to other universities, and
4. Compare year-on-year of student satisfaction levels from the National Student Survey

Items 1 and 3 are still an ambition and should be considered from the next research. Item 2 forms the basis of the main analysis of this study. Item 4 is discussed in the following section.

5.1 Exploration of Factors Causing Black Ethnicity Students to be Less Optimistic

Carrying on from the previous year’s study (2021), data comparisons were conducted to show any major similarities or differences in the data distribution. All data variables which exist in both years’ studies were included and in the case of the current study the extra variables of average component mark (how the student is currently progressing in their studies), average module score (how the student performed from the previous year) and if they attended the CODE-It initiative were also included.

Comparative Analysis of Year-on-Year Data.

Ethnicity. Comparing ethnicity between 2021 and 2022, significant differences occurred in White Ethnicity (~8% increase) and Other Ethnicity (~6% increase).

Gender. Comparing gender between 2021 and 2022, no major differences were seen in percentages.

Disability. Comparing disability between 2021 and 2022, a 6% rise was seen in those with some form of disability.

Component Mark. Module marks were compared using average component mark and average module score. On average module score was down by 8%, due to the natural increase in difficulty of study between first and second years at university commonly referred to as “Second Year Slump” (Milson, 2015). The next survey should include a set of questions asking if the student found the next level of study more difficult than the previous year.

Optimism. Optimism can be seen to have improved by 3 points at the minimum level, with a drop of 1 point at the maximum. The mean was the same and the median was within 1 point. Therefore, it can be summarised that optimism did increase. This might be explained by the post Covid-19 pandemic effect of the return to in-class teaching rather than on-line. Other factors within this explanation might be, the CODE-It initiative, giving students the chance to collaborate on fun team-based activities, students being able to interact with their classmates in lectures and tutorials and having face to face in person time with lecturers. In addition, speakers from relevant industry backgrounds of all ethnicity types were invited to talk to the students about a range of topics including interview tips, C.V. preparation, how to achieve higher grades and projects in industry within relevant fields.

5.2 Analysis of Optimism Score by Feature Grouping

Further analysis was conducted into the optimism scores to see how various variable groupings accounted for the results. The groupings mirrored the previous sections of ethnicity, gender, disability, and component mark.

Optimism Grouped by Ethnicity. Grouping by ethnicity showed that White Ethnicity contained the minimum and maximum optimism score and was on average pessimistic. Those students with Black Ethnicity although on average were pessimistic, had improved on their minimum score from the previous year. Asian Ethnicity on average were pessimistic, whereas students of Other Ethnicity had average optimism.

Optimism Grouped by Gender. Grouping by gender was a key factor in the mean and median values of the optimism score, though there was no major difference at the extremes.

Optimism Grouped by Disability. There was no accountable difference of optimism if the student was disabled or not.

Optimism Grouped by Component Mark. Grouping optimism by binned average component mark showed that those students with marks <50 (21%) had the lowest mean and median optimism score. Those with marks >=80 (7%) had the highest mean and median score due to feeling positive about their academic achievement obtained.

From the analysis conducted in this section there was an 8% increase in White Ethnicity students, a 6% decrease in Other Ethnicity compared to 2021, with Black Ethnicity, Asian Ethnicity and Not-Known seeing changes below 5%. Gender has remained around the same as 2021 with any changes being below 5%. Disability has seen a 6% increase for those with a disability based on 2021 and below 5% for those who do not. The students’ median and mean component grades have decreased by 8~9%. This is to be expected with the increase in difficulty between year one and year two undergraduate courses. Optimism has risen at the lowest level by 3.00 points (from -8.00 to -5.00), dropped at the highest level by 1.00 point (from 9.00 to 8.00), the mean has remained the same and the median has dropped by 1.00 point (from 2.00 to 1.00). Grouping optimism scores by ethnicity it was observed that Other Ethnicity had the highest mean score at 1.25, followed by Black Ethnicity (0.93), then White Ethnicity (0.42) and finally Asian Ethnicity (0.40). White Ethnicity had the lowest (-5.00) and highest (8.00) optimism scores. Grouping optimism scores

by gender it was observed that females were on average more optimistic (1.81) than males (0.02) with minimum and maximum values being within 1.00 point of each other. Grouping optimism by disability showed no significant differences. Grouping optimism by binned average component mark showed that those students with an average <50 had the lowest maximum (3.00), second highest minimum (-4.00) and lowest mean (-1.00) scores.

5.3 Regression Tree Analysis of Optimism Scores

Two feature sets were used in regression tree analysis. The first set without Average Component Mark and the second set including it to see what effect it had. Compared to the previous year's study (2021) the variables Qualification and Work Experience could not be used as they were not recorded on the survey. In the current study the following predictor variables were used: Attended CODE-It, Gender (M/F), Age, Ethnicity, Disability (Y/N), Full or Part-time and Study Level (Degree or Foundation).

5.3.1 Feature Set 1

A regression tree analysis, using the previously mentioned predictor variables, was conducted, and produced a variable importance. Specifically, it was observed that the 10% of Black Ethnicity students who were at or below an optimism score of -1.50 in 2021 were no longer there and the lowest score of -0.89 (29%) was comprised of White Ethnicity students.

The next group with a score of 0.29 (10%) was a combination of Asian, Black and Other Ethnicities. In both cases this applied to male students who attended a foundation year prior to entry.

The next set of scores 0.00 and 1.60 were males of all ethnicities who did not partake in a foundation year. It can be seen in this group which was evenly split at 15% each that for those who attended the CODE-It initiative, their optimism score was 1.60 (compared to 0.00 for those who did not) and at 1.60 this was moving away from pessimism to an average optimism score. Showing a clear positive effect on optimism scores, regardless of demographic factors by attending CODE-It.

The final set of scores (31%) are for females split by study level. For those who did not attend a foundation year (19%) the score was pessimistic in contrast to those who did attend a foundation year (12%) with the highest optimism score of 3.10 which was just above the high average level.

It can, therefore, be stated that compared to the previous year, Black Ethnicity students had improved their level of optimism at 2.90 which was near the highest level of 2021 of 3.00. White Ethnicity male students (28%) who attended a foundation year had the lowest optimism score of -0.89. For male students who attended CODE-It optimism scores were improved by 1.60 points. Foundation year female students were 3 points more optimistic than the equivalent non foundation students.

5.3.2 Feature Set 2

Feature Set 2 included the average component mark, but it did not produce significant variable importance. Specifically, it was observed that when average component mark is added as an explanatory variable, there were two distinct groups. Students with an average component mark of <51 and student with an average component mark of >=51. For marks <51 (27%) students were pessimistic at -0.93 regardless of any other variable. Those students with an average module score >=51 was further split into two groups, male and female. The male group was split into 16% with a score of -0.56 and are those who attended a foundation year. For those male students who did not attend a foundation year (27%) their score was 1.20 which was heading towards an average optimism score of 2.00. The final distinct group (30%) and the most optimistic by one whole point with an average optimism score of 2.20 were females. It can also be observed that those groups at most risk when taking into account optimism as an indicator are students with average component marks <51 (27%) and male students who attended a foundation score with average component mark >=51 (16%).

5.4 Analysis of Attendance of CODE-It

Although the variable importance of attending CODE-It showed relevance in the Feature Set 1 of the regression tree analysis, it did not show significant relevance in the Feature Set 2. Therefore, a separate analysis of its effect on the

average increase of marks was conducted. The attendance based on ethnicity was also explored. This time the results were of significant relevance. Specifically, the results showed that 26 students attended CODE-It. For 11, their average module mark increased by a median of 10 and average of 11 points, however 15 students saw a drop in their average module mark by a median of 12 and average of 16. This contrasts with 30 students who did not attend CODE-It where 10 saw a median increase of 9 and an average increase of 32. Finally, there were 20 students who did not participate in CODE-It and saw a median decrease of 17 and an average decrease of 56. Of those 26 students who attended CODE-It and graded their experience (positive or negative) the majority 22 (85%) thought it was a positive experience compared to 4 (15%) who did not.

Analysing the data and grouping by ethnicity showed that the largest participating group of students by ethnicity based on percentage of ethnic group were those who identify as Black Ethnicity (60%), then White (42%), Asian (40%) and Other (25%). This could in part explain the increase in optimism levels in that group and further research should be conducted to ascertain a correlation. In addition, the data analysis by attendance of CODE-It by gender showed that 47% were female students while 43% were male. The attendance of CODE-It by study level showed a higher attendance by foundation degree students (58%) compared to a 42% of degree level students.

All this information suggests that attending CODE-It had a positive effect on the participant students' grades as well as showing a slight positive increase in grades and a less negative effect on grade reduction. Specifically, most students (85%) who attended CODE-It thought it was a positive experience. Furthermore, a larger percentage of Black Ethnicity students attended CODE-It. This may be one of the reasons for an increase in optimism in that group this year, compared to last. Finally, there is no significant difference in attendance based on gender or study level (both important variables in the regression tree analysis findings) being at 5% in each case. From these results, it could be argued that CODE-It should be continued as a worthwhile exercise, further refined and its effects studied in any similar future studies. With the analysis completed in this section the implications of the findings are discussed in the following section.

6 Implications

The major implications found from the analysis and interpretation of the survey data for this study were found to be four prominent issues, split into two related groups. The first group a continuation of the findings from the previous year's study (2021), involving the ethnicity group with the lowest average optimism score and the optimism scores throughout the whole group of students.

Ethnicity of students with the lowest optimism score: The student ethnicity group with the lowest optimism score in the previous survey and analysis (2021), those of Black Ethnicity, were no longer the lowest ethnicity group in this year's survey and analysis (2022). The ethnic group with the lowest optimism group are now those students who identify as White Ethnicity. The increase in optimism of the Black Ethnicity students may be attributable to the higher proportion of that group of student's participation (60% attendance) in the CODE-It initiative compared to the White Ethnicity group of students (42% attendance).

Slight increase in the lower optimism score year-on-year: Optimism on average has increased at the lower end by three points, dropped by only one point and remains approximately equal at the mean and median in both years. Returning to in person interaction with classmates and lecturers could be a major factor in reducing the minimum score compared to the previous year's study (2021). However, there is still a very real post pandemic effect being experienced by many students, especially around matters of hardship and finance (Shearing, 2022). As it was possible to observe the effects of the average component mark in the regression tree analysis, a second feature set including that data (for cases where it was available) was run. It found that the least optimistic students were those with a score ≤ 50 . For each feature set, females remained the most optimistic.

Decrease in median average component score year-on-year in line with recognised "Second Year Slump": With the addition of the average component mark (2022) and average module result (2021) a median and mean drop of 8% was observed. The so called "Second Year Slump" is a phenomenon researched in the US but recognised as an international experience (Milson, 2015). Students are observed to become generally less satisfied with their university experience and their priorities change. They also reported feeling unprepared for the overall workload of the second

year, in particular the volume of assessments. This is something which should be factored into and observed in the next survey.

Quantifiable positive effect of the CODE-It initiative on average component score and optimism levels: It was possible to analyse the effects of the CODE-It initiative against the survey data collected. This was done by comparing average increase and decrease in component score and showed that those who attended CODE-It saw less of a decrease (by 5 points) and a slight increase (by 1 point) compared to those who did not attend. Grouping the CODE-It attendance by ethnicity showed that those students who identified as Black Ethnicity had a higher proportion of attendance (60%) and were no longer the student ethnicity group with the lowest optimism score. Finally, for those students who did attend CODE-It, 85% indicated that they felt it was a worthwhile exercise. Therefore, it is recommended to continue running CODE-It while improving and continuously measuring its effects.

7 Limitations

There were several limitations encountered conducting the research, one of which would have had no effect, it would just have been interesting to have other data, and two which it could be argued could have had a small effect on the analysis, regardless interesting and relevant conclusions were obtained for this study.

The **first limitation** was the non-ability to roll out the survey to multiple university schools.

The **second limitation** was the level of engagement by students. Although all the students who continued to the second year of their academic studies were asked to complete the survey it was not possible to obtain feedback from all of them. However, a statistically significant number of students did complete the survey.

The **third limitation** was the lack of data from students who did not continue their studies into the second year. For those students who did not continue into the second year, because they dropped out, although they were contacted, none of them responded. It is difficult to postulate the reason for this, therefore, a better mechanism for obtaining feedback in such cases might be sought in order to gather as much relevant data as possible.

The **fourth limitation** was the exclusion of variables in regression tree analysis. Specifically, not all the variables used in the regression tree analysis of the previous study (2021) were available in the current study. These were: Qualification and Work Experience. However, this seemed not to have a detrimental effect on the Feature Set 1 analysis which gave comparable results in the previous study (2021).

8 Conclusion

The aftereffects of the global pandemic are still being experienced by students in the UK. Even though teaching has returned to in class and face to face, this could be a factor that has attributed to optimism levels not rising significantly overall. However, there was a slight increase in the lower level. The second-year study has seen those students who identify as Black Ethnicity moving from the lowest optimism group to the second to lowest. The lowest optimism group being those students who identify as white. This might be explained in part, by a higher percentage of the Black Ethnicity students having taken part in the CODE-It initiative. Furthermore, the average module scores have slightly decreased at the overall mean level, but this is recognised as a naturally occurring phenomena known as “Second Year Slump” (Milson, 2015). It is important to monitor this, as average component mark featured as the most important variable in the regression tree analysis.

9 Recommendations for further research

The first recommendation for further research is related to the CODE-It initiative. The CODE-It initiative had a positive effect on the grades of students and could be considered as a main reason for the increase in optimism levels of the Black Ethnicity students. Furthermore, by those students who attended the CODE-It initiative 85% stated that it was a positive experience. Therefore, it is recommended to further refine and run more surveys to obtain more student feedback.

The second recommendation is related to the inclusion of features found to be good predictors of optimism from other studies. It is important to address factors found in the literature review from other research, namely the potential effect of commuting as a predictor (Hillman, 2021b), student hardship, and financial factors (Shearing, 2022). Furthermore, with the 8% decrease in average module score attributed to the natural increase in difficulty level between year 1 and

2 as an undergraduate student (Milson, 2015), it might be appropriate to include survey questions regarding their academic studies experience from year 1 to year 2.

A third recommendation is to study the effect of ethnicity groups as a contributing factor to levels of optimism. A separate study should be conducted on how the ethnic backgrounds contribute to optimism levels among students and how the levels can be improved.

Finally, including other universities in further studies for comparative analysis is recommended. This could be used to obtain vital information of computing students' welfare and optimism levels and suggest comparable group exercises to CODE-It for those universities.

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