Understanding Factors Affecting Performance in an Elementary Biostatistics Course at Harare Institute of Technology

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Abstract   Different factors affecting academic performance of students in biostatistics at Harare Institute of Technology were considered. A questionnaire was used as an instrument for data collection and was distributed to all students who had done the biostatistics course and were present on campus. Coursework marks were used as a measure of performance. Factors considered in this investigation were age of students, gender, high school achievement, lecture attendance, type of accommodation, time spend studying the course per week, family income, birth order, family size, achievement in ordinary (O'Level) and advanced level (A'Level) maths and the student's studying method. The students were also asked to rate the knowledge of the lecturer and give suggestions on how the pass rate in biostatistics could be improved. A stepwise regression method was used to select those factors linearly correlated with coursework which significantly affected performance. Chi-squared tests were used to check the association between categorical variables while correlations were used to assess linear relationships between quantitative variables. Results from stepwise regression indicated that high school achievement (number of points at A'Level) affected performance. Age of students and gender were associated with performance.

Cite This Article: Kudakwashe Mutangi, "Understanding Factors Affecting Performance in an Elementary Biostatistics Course at Harare Institute of Technology." *American Journal of Educational Research*, vol. 4, no. 6 (2016): 479-483. doi: 10.12691/education-4-6-6.

1. Introduction

The performance of students in biostatistics at Harare Institute of Technology (HIT) has been poor over the years. This has resulted in several students carrying the course to the next academic year thereby increasing the student work load. Students at HIT do an average of eight courses per semester with no supplementary examinations should the student fail a course. This has the effect of increasing the number of courses per semester to nine or ten depending on the number of failed courses. No formal report has been compiled so far on the possible causes of poor performance in the Introduction to biostatistics course at HIT. This paper considers the following factors: class attendance, age of students, gender, high school achievement (number of points at Advanced level –A'Level), time spend studying biostatistics, studying method, type of accommodation, family income and lecturer effect.

Several studies have been done by many researchers about factors affecting student performance in various disciplines, settings and geographical locations at different levels of education. Reference [1] considered factors affecting performance in an introductory biochemistry course at the university of the west indies, [2] considered factors affecting students at Islamia university sub campus in Pakistan, [3] concentrated on class attendance, [4]

studied factors affecting achievement in first course in calculus, [5] reported that parent's education and family income affected student performance. Other notable authors include [6,7,8,9,10].

Introduction to biostatistics was first introduced at Harare institute of Technology in 2011 to first year Pharmaceutical Technology students. In subsequent years, the course was offered to biotechnology (Biotech) as well as Food Processing technology (FPT) students bringing to three, the groups of students taking the course. The students are taught in one lecture room at second year level. The teaching of the course requires examples and applications in those different disciplines. The entry requirements for the three groups of students differ in that in FPT there is no requirement for A'Level mathematics, while Pharmacy takes high flying students with excellent A'Level passes including mathematics. In some instances applicants hold diplomas from polytechnics with varying mathematics backgrounds if any.

Although a lot of research has considered some of the above factors, a brief summary of how they affect this study is essential.

1.1. Class Attendance

Statistics like mathematics is a cumulative subject that join different concepts together, in other words what is

learnt today will be used tomorrow in another chapter. A student who misses class lectures may find it difficult to catch up. Reference [1] however cites the use ICT and internet as one of the possible causes of absenteeism from lectures since students have alternative sources of knowledge. Reference [11] found that absenteeism increased the probability of a student giving incorrect responses by as much as 14%. [12] Reported that the major reasons given by students for absenteeism included assessment pressures, poor delivery of lectures, timing of lectures and work commitments. A multitude of other authors report a strong relationship between attendance and performance: [3,5,13,14,15].

1.2. Age of Students

Age of student doesn't seem to affect academic performance, [1] reports that academic performance of mature students did not differ from that of younger students. [8] found that although being older in age lead to better cGPA scores, it does not have a significant effect on academic performance. Mature students would not be at a disadvantage [16,17] agrees with [16]. Age was considered a more important factor than gender in contributing to success [18,19]. In this study, students who entered the university based on them having acquired a diploma in their different fields tend to be more mature (older) than others.

1.3. Gender

Zimbabwe has a gender policy that affords equal opportunities for all including in higher education. The recruitment of students is therefore gender sensitive. There is no consensus on the performance of males and females. [19] found that male students outperformed female students in sciences but in reading and writing, females did much better .[21] and [22] are in agreement that female students outperform their male counterparts at all levels of the education system. There was no significant difference based on gender on the standardized science test scores [23]. Reference [24] showed that men performed better than women in certain settings while women performed better than men in other settings. Others like [25] reported that gender did not play a role in academic performance. [26] suggests that females have better study skills than males, while [27] agrees [26] and describes females as more academically responsible and thus less likely to be absent from lessons thereby suggesting that attendance and performance are related.

1.4. High School Achievement

Harare Institute of Technology recruits its students mainly from Zimbabwe with a minimum of two A'Level subjects. An A in a subject attracts 5 points; a B attracts 4 in that order up to grade E with 1 point. The entry points differ from discipline to discipline with Pharmacy taking students with the highest number of points. It is necessary to check if a relationship exists between the number of points in high school and achievement in biostatistics. [28] reported a significant correlation between SAT scores and grades in Principles of economics while [18] stated that the other indicator of scientific strength of students could

be the marks they obtained during their secondary school studies.

1.5. Time Spend Studying the Course Per Week

It is expected that the time spend studying biostatistics should be related among other factors to achievement in the course. Previous research showed a negative correlation between the number of hours per week spent studying economics and the grade obtained in the course [28]. [4] reported a very weak negative correlation between calculus achievement and study time.

1.6. Type of Accommodation

HIT has boarding facilities which are inadequate to cater for every student. Some students travel long distances to and from college every day of the week. As a result of this, a lot of time is lost in travelling and the students also get fatigue. This factor was incorporated in the study to check if it affects achievement in biostatistics. In the study by [28], a weak correlation between university housing and grades was noted.

1.7. Family Income

A lot of research has considered family income as a factor affecting academic achievement. Socioeconomic status of students and their families showed moderate to strong relationship with academic achievement in [29], while [30] concurred. Reference [31] differs with [30]. In a study on social and educational background, students who come from poor socioeconomic and educational background performed relatively better than those from higher socioeconomic standings [32].

1.8. Other Factors

Other factors which might have an effect on achievement in biostatistics include: birth order, family size, O and A level maths, study method and lecturer effect, in other words, how do students rate the lecturer's knowledge of the course. Should the rating be low, it possibly has the effect of causing absenteeism and also failure in the course.

1.9. Objectives of the Study

The main objective was to assess the effect of age, gender, high school achievement, hours of study per week, class attendance, type of accommodation and family income on student.

2. Methods

All the students doing biostatistics and not on industrial attachment were included in the investigation. 75 Questionnaires were distributed to all the students in Food Processing Technology, Pharmacy and Biotechnology departments who had taken the biostatistics course and 57 or 76% responded. Self reported coursework marks were used as a measure of the student's performance and hence as a dependent variable. Under the Institute regulations, final exam marks are confidential and were not used as a

measure of the student's performance. The questionnaire had four parts A, B, C and D. Part A had biographical factors such as age, sex, order of birth, parent/guardian's occupation and family size. Part B involved entry qualifications such as number of points at A'Level, grade in O and A level maths. Part C considered academic factors which included among others, hours of study per week, study method, class attendance and so on. The last section was on non-academic factors such as type of accommodation, family income and employment (whether the student is employed elsewhere). The method of analysis involved correlations between variables, Chi-square tests of association between categorical variables as well as multiple linear regression analysis with percentage coursework as the dependent variable, independent variables were: hours of study (hours) and number of points at A'Level (Alevel). Coursework marks were also graded on the following scale 75-100: 4, 65-74:3, 50-64: 2 and 0-49: 1 thereby creating a new categorical variable (cwcat) which was used in chi-square

tests of association. It was assumed that students answered the questions truthfully especially the coursework marks in the course, and that the number of returned questionnaires was representative of the target population since some questionnaires were not returned. We also assumed that the coursework marks reflects the students' capability in the course and is a true reflection of the students' overall performance.

3. Results and Discussion

Correlations between the independent variables and coursework marks were assessed as well as correlations between the independent variables. A multiple linear regression with coursework marks as the dependent variable with points at A'Level and hours of study as independent variables was considered. A stepwise regression method was used to select the most suitable model.

Table 1. Correlations between variables

	Lectureatt	Fincome	Omaths	Amaths	birthorder	Cwcat
Lectureatt	1	-0.041 (0.783)	0.181 (0.195)	0.138 (0.345)	-0.020 (0.884)	0.124 (0.358)
Fincome		1	0.393 (0.008)	0.204 (0.190)	0.025 (0.865)	0.098 (0.513)
Omaths			1	0.641 (0.000)	0.145 (0.301)	0.210 (0.130)
Amaths				1	0.162 (0.265)	0.313 (0.028)
birthorder					1	0.222 (0.097)

From Table 1, only A'Level maths is significantly correlated with coursework. It is also clear that success in O'Level maths leads to success in A'Level maths since the two are significantly correlated. There is also a significant relationship between family income and success in Ordinary level mathematics. The following table (Table 2) shows correlations of some selected independent variables with coursework marks.

Table 2. Correlations of some selected variables with coursework marks

	Famsize	Amathsm	Hours	Alevel
Coursework	0.027(0.841)	0.113 (0.401)	-0.037 (0.794)	0.331 (0.020)

Family size, A'Level maths marks and hours of study are not related to the coursework marks. The A'Level maths marks (Amathsm) were estimated from the grades

obtained in Maths at A'Level, there is however a significant correlation between the grades in A'Level maths and cwcat (coursework marks grades). The number of points scored at A'Level (Alevel) are correlated with the coursework marks (p=0.020). A multiple linear regression model was considered with coursework as the dependent variable and the two variables (Hours, Alevel) as independent variables.

Stepwise Regression Results:

Based on the 45 observations (no missing data) and using stepwise regression, Hours was rejected and the resulting model was:

$$\text{Coursework} = 40.052 + 2.044 * \text{Alevel}$$

Hours was rejected possibly because it had insignificant correlation with the dependent variable.

Table 3. Analysis of variance table with coursework as dependent variable and Alevel points as independent variable

	Model	Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1125.062	1	1125.062	4.945	.031[a]
	Residual	9782.715	43	227.505		
	Total	10907.778	44			

a. Predictors: (Constant), points at Alevel
b. Dependent Variable: coursework mark

There is significant regression suggesting that high number of points at A'Level (high school achievement) would result in success in biostatistics at HIT.

We now consider results for all the factors one by one.

Class Attendance

There was no significant correlation (r=0.124, p=0.358) between class attendance and coursework marks suggesting

that students attending lectures and those not attending lectures had comparable coursework marks. [1] suggested that students may have other sources of knowledge such as ICT and internet. The results however differ with [5] and [3] who reported a strong relationship between attendance and performance.

Age of Students

A chi-square test of association revealed that age of students was associated with coursework (χ^2=22.967), p=0.006. These results are in agreement with [18] and [19]. 29% of students in the age group 16-21 scored higher than 50% while 54.5% in the 22-27 also scored higher than 50% in coursework. It appears clearly that mature students are performing better than younger students.

Gender

Gender and coursework were associated, with χ^2=7.988, p=0.046. 36.8% of students who scored above 50% were females while males constituted 52.6%. 22.2% of the females scored below 50%. In this course (SST216), males outperformed females which agree with [20] but in disagreement with [21], who found that female students outperformed their male counterparts at all levels of the education system.

High School Achievement

High school achievement in Zimbabwe is measured on the number of points scored at A'Level. There was a significant correlation between coursework and points at A-level. A regression model above confirms a significant relationship between the two variables. The results agree with that of [28] who reported a significant correlation between SAT scores and grades in Principles of Economics.

Hours of study per week

There was a weak negative and insignificant correlation (r=-0.037) between hours of study per week and coursework which agrees with [28]. [4] reported a very weak negative correlation between calculus achievement and study time.

Type of Accommodation

There was no association (χ^2=5.145, *p*=0.953) between type of accommodation and coursework achievement. Students were asked to indicate whether they live on campus, near campus or far from campus. From the results, it's apparently clear that performance in coursework was not affected by distance from campus.

Family Income

Family income was not associated with achievement in coursework , these results differ with [29,30,31]. In this study, family income was however correlated with success in O'Level mathematics.

Other Factors

There are many other factors not considered so far which formed part of this study, these include order of birth, family size, lecturer's knowledge, relevance of examples given in lectures and tutorials, and how the pass rate in SST216 should be improved. Results showed that order of birth, O'Level maths and family size were not correlated with coursework, while achievement in A'Level mathematics was significantly correlated (p=0.028) with coursework. We now consider the remaining factors one by one:

- Learning resources:

71.9% of the students relied on class notes and 68.6% of them scored above 50% in their coursework. 28.1% of students used books and the library's e-resources. All the students who used books and e-resources scored above 50% of their coursework. A chi-square test revealed no significant association between learning resources and achievement in coursework.

- Study Method

Students were asked to indicate if they read and study alone, with a friend or as a group. There was no association between study method and coursework.

- Lecturer's knowledge

Students were asked to rate their lecturer's knowledge of the course and tick appropriate boxes: 0 =poor, 1= satisfactory, 2= neutral, 3=good and 4= excellent. Based on descriptive statistics, a mean score of 3.05 with a standard deviation of 1.025 was obtained. This shows that the lecturer was generally ranked as good in terms of knowledge of the course. The frequency distribution provided the following Statistics.

Table 4. Percentage ratings of lecturer's knowledge of SST216

	Excellent	Good	Neutral	Satisfactory	Poor
% rating	40.4	36.8	12.3	8.8	1.8

About 77.2% of the students in the study rated the lecturer as good to excellent.

- Relevance of class lecture examples

Students were asked to rate the relevance of class lecture examples to their different disciplines (Pharmacy, Biotechnology, and FPT). 0= irrelevant, 1= satisfactory, 2 = neutral, 3= relevant, 4 = very relevant. The following table shows the ratings irrespective of discipline or program of study.

Table 5. Percentage ratings of relevance of class examples

	Very relevant	Relevant	Neutral	Satisfactory	Poor
% rating	21.1	56.1	3.5	19.3	0

- Improvement of Pass Rate in the course

The respondents were asked to suggest ways in which the pass rate in the course could be improved.

Table 6. Suggestions on how results could be improved.

Suggestion	% response
Increase number of tutorials per week	71.9
Increase the number of Lectures per week	7
Avail more books	1.8
Introduce an elementary statistics course before SST216	10.5

The majority of students suggest the increase of more tutorials per week as a possible measure that may improve success in SST216.

4. Conclusions and Recommendations

This study relied on self reported coursework marks which may not be very accurate. Coursework marks are also based on assignments and tests where students share ideas and may not reflect truthfully the student's potential. It can however be concluded from this study that high school achievement influenced academic performance in biostatistics. Age and gender were also found to be associated with performance in biostatistics. The lecturer rating was high suggesting that students were confident of his knowledge of the course. Students recommended the increase in the number of tutorials per week as a means of improving performance in the course. It was also recommended that an elementary statistics course be introduced before this course is taught. I recommend for further studies, the use of the final exam mark as a measure of performance in biostatistics and that further

analysis be done based on individual disciplines (Pharmacy, Food Processing Technology, and Biotechnology). This study considered all students doing biostatistics regardless of their program of study.

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