A RESEARCH ON THE EFFECT OF CO-CURRICULAR ACTIVITIES ON THE ACADEMIC PERFORMANCES OF THE STUDENTS

Introduction

Education is a broad concept that exceeds the four walls of classroom. The main aim of the education is to proselytize the all-round development and that's when the importance of co-curricular activities comes into highlight. Co-curricular activities are those which are undertaken side by side with academics. It gives the opportunity to develop particular skills and exhibit their non-academic abilities.

To fulfil the aim of the education, there is a foremost need of striking a balance between syllabus, curriculum, book, and also co-curricular activities beyond that. Therefore, understanding of co-curricular activities and their integration with academics has become the need of hour.

Thus, to understand the cause and effect of co-curricular activities on academics we will pitch in with the Design of Experiments.

Design of Experiments (DOE) is a planned approach that allows an experimenter to plan the experiments and determine cause-and-effect relationships. DOE is extensively used in laboratories and research in natural science, engineering, and nearly all branches of social science because it reduces the number of experiments that need to be performed. **Ronald A. Fisher** was the founder of 'Design of experiment'. So, we will design an experiment known as 'Factorial Experiments' to get the better study of the impact of co-curricular activities on the academics.

Factorial experiment is an experiment whose design consists of two more factors, each with discrete possible values or "levels", and whose experimental units take on all possible combinations of these levels across all such factors. It allows the effect of several factors and even interactions between them to be determined with the same number of trials as are necessary to determine any one of the effects by itself with the same degree of accuracy.

Abstract

The present study of the influence of co-curricular activities on the Academic performance of College students reveals that there is not much difference in the grade of the students due to those activities. Information was collected by circulating a questionnaire throughout the students of Delhi University who have been a part of an ECA Society or a club. After receiving responses from 200+ Students we made use of Factorial Experiments to carry out the appropriate analysis. In accordance with many reports and research papers published there is significant impact of Co-curricular activities on Grades, but our study has led us in a different direction concluding with the thought process that there is actually no significant influence of ECA Activities on the academic performance of a student throughout their college curriculum.

Theory: a 2^3 Factorial Experiment

(Please note that we have only included the important information here and not all the derivations)

Factor A is Course Difficulty

Factor B is Regularity (Attendance)

Factor C is Future Priority

The 2^3 design is a two-level factorial experiment design with three factors (say factors A , B and C). This design tests three ($k = 3$) main effects, **A, B and C**; three ($\binom{k}{2} = \binom{3}{2} = 3$) two factor interaction effects, **AB, BC, AC**; and one ($\binom{k}{3} = \binom{3}{3} = 1$) three factor interaction effect, **ABC**. The design requires eight runs per replicate.

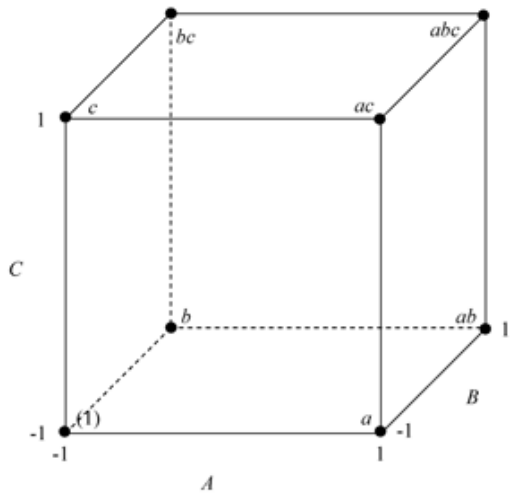
Yates Order / Notations

The eight treatment combinations corresponding to these runs are (1), a, b , ab , c, ac, bc and abc.

This order of writing the treatments is called the *standard order* or *Yates' order*. The 2^3 design is shown in figure (b) below. The design matrix for the 2^3 design is shown in the following figure. The design matrix can be constructed by following the standard order for the treatment combinations to obtain the columns for the main effects and then multiplying the main effects columns to obtain the interaction columns.

Treatment Name	Factors		
	A	*B*	*C*
(1)	-1	-1	-1
a	1	-1	-1
b	-1	1	-1
ab	1	1	-1
c	-1	-1	1
ac	1	-1	1
bc	-1	1	1
abc	1	1	1

(a)



I	*A*	*B*	*AB*	*C*	*AC*	*BC*	*ABC*
1	-1	-1	1	-1	1	1	-1
1	1	-1	-1	-1	-1	1	1
1	-1	1	-1	-1	1	-1	1
1	1	1	1	-1	-1	-1	-1
1	-1	-1	1	1	-1	-1	1
1	1	-1	-1	1	1	-1	-1
1	-1	1	-1	1	-1	1	-1
1	1	1	1	1	1	1	1

(b)

Each treatment combination has r replicates, so the total number of observations are N =2^3r = 8r that are to be analysed for their influence on the response.

Using the above tables, we calculate the simple mean effects and the interaction effects using the concepts of Orthogonality and Contrast.

Sum of Squares for the effects are easily computed because each effect has a corresponding single degree on freedom contrast. In the 2^3 design with r replicates, the sum of square for any effect is

SS = (Contrast)^2/8r

Defining the Hypothesis:

To investigate how the given factors, affect the response, the following hypothesis tests need to be carried:

1) $H_0 \quad : \quad \beta_1 = 0$
$H_1 \quad : \quad \beta_1 \neq 0$

This test investigates the main effect of factor **A (Course Difficulty**). The statistic for this test is:

$$(F_0)_A = \frac{MS_A}{MS_E}$$

where MS_A is the mean square for factor **A** and MS_E is the error mean square.

NOTE:

Hypothesis for the other main effects, **B (Class Regularity)** and **C (Priority)**, can be written in a similar manner.

2) $H_0 \quad : \quad \beta_{12} = 0$
$H_1 \quad : \quad \beta_{12} \neq 0$

This test investigates the two-factor interaction **AB**. The statistic for this test is:

$$(F_0)_{AB} = \frac{MS_{AB}}{MS_E}$$

where MS_{AB} is the mean square for the interaction **AB** and MS_E is the error mean square.

NOTE:

Hypotheses for the other two factor interactions, **AC** and **BC**, can be written in a similar manner.

3) $H_0 \quad : \quad \beta_{123} = 0$
$H_1 \quad : \quad \beta_{123} \neq 0$

This test investigates the three-factor interaction **ABC (Course Difficulty*Regularity*Priority)**. The statistic for this test is:

$$(F_0)_{ABC} = \frac{MS_{ABC}}{MS_E}$$

where MS_{ABC} is the mean square for the interaction **ABC** and MS_E is the error mean square.

If the F (cal) will be more than F (tab) we will reject the Null Hypothesis otherwise we will accept our Null Hypothesis. Similarly, can be done when p value is less than level of significance, we will reject otherwise we shall accept.

In the table below we have listed all the factors at their respective levels that were taken into account to conduct this study.

Levels/ Factors	Course Difficulty	Attendance	Future Priority regarding ECA
0	**Science**	**Less than 50%**	**Will pursue**
1	**Arts and Commerce**	**50 and more**	**Will not pursue**

Method of data collection

The information was gathered through a detailed questionnaire as follows –

1. Which course do you belong to?
- Science
- Commerce
- Arts

2. Which Year?
- 1st Year
- 2nd Year
- 3rd Year

3. Are you a part of any ECA (Extracurricular Activity) society?
- Yes
- No

4. Which ECA Society?
- Dance
- Music
- Literary
- Fine arts
- Dramatic
- Other:

5. How frequently do you participate in competitions or workshops relating to extracurriculars?
- Frequently
- Rarely
- None

6. What's your class attendance in college? (in %age)
- Less than 50
- Between 50-70
- More than 70

7. How much time do you devote to self-study on a regular day?
- Less than 1 Hour
- Between 1-2 hour

- More than 2 Hour

8. Enter your CGPA till now (Entries taken are purely for research purpose and will not be disclosed)
- Your answer

9. Do you think creative fields/the arts are a viable career path?
- Your answer

10. Do you plan to enhance your talent further and take it up professionally?
- Yes
- No
- Maybe

DOE was utilized to determine the optimum number of experiments to be run so that sufficient data was available for analysis. The designs were prepared for three processing parameters: Course Difficulty, Class Regularity and Priority.

It was decided that we conduct a 3^2 factorial experiment. Hence, three factors taken into consideration were:
a) **Course Difficulty** - Based on whether the respondent had a science, arts or humanities course, difficulty of the course was marked accordingly. We considered it on 2 levels. Science was taken to be difficult whereas commerce and arts were taken as easy. Since science courses include practical's, the number of classes per week automatically goes up which results in longer class duration. The students who participate actively in their societies often end up missing practical classes, which has an adverse effect on their grades. Also, as a general notion science courses are considered to be tougher as compared to commerce and arts courses.
b) **Priorities** - Respondents were supposed to choose their individual level of priority as shown in the table above, depending on them how much likely it is that they will take a career path based on their respective ECA activity. This factor is divided into 2 levels. Firstly, the students who want to pursue in the field of their ECA activity and secondly the students who do not fall in the above category.
c) **Class Regularity** - This factor was chosen as it establishes a direct link to academics and the time spent by the respondents to attend classes, since there are marks for attendance and people who do attend classes tend to do better in internals per se. This factor is also divided into 2 levels, those levels are less than 50% and more than 50%.
The questionnaire also included questions regarding time devoted to self-study and the frequency of the ECA students attending competitions.
The target of this survey were people belonging to various ECA societies including music, dance, photography, word craft, fine arts, dramatics etc from various colleges in Delhi University. Data was also collected from some of the non ECA students so that the difference between an ECA and non ECA student could be established. We were able to collect the data from 200 students in the sample.

The effect of the parameters on output response parameters was studied. Experimentation for various grades was carried out to observe the effect of controlled variation of different factors. The results were analysed to determine an optimum set of parameters in order to ensure minimum error.

Data Analysis

The SPSS (Statistical package for social sciences) was employed to obtain the results.
Due to the randomness of the data obtained through the survey, all the replicates did not have an observation per treatment, which implies all the replicates were not complete. Hence, we took only those replicates which had all the treatment observations available. Therefore, the size of our sample reduced to 40.
Where,

Number of treatments = 2*2*2= 8
Number of replicates = 5

Number of total observations = 40

A three-way mixed ANOVA was run to understand the influence of our three factors:
Course difficulty, Regularity and Priority on the Grade point. A significance level of 0.05 was used to test the significance of the results.
We compare the p value (Indicates the probability of obtaining the observed *F*-value if the null hypothesis is true) with the 0.05 level of significance.

1) We observe from the ANOVA table that the three simple main effects are not statistically significant. Since level of significance is 0.05 the p values are 0.581,0.372 and 0.212 for each of three factors hence, we accept our Null Hypothesis.

Similarly, the two interactions AB, BC, and AC are also not significant at p values 0.169, 0.431 and 0.856. and ABC is also statistically insignificant at p value = 0.243 having F (1,32) =1.418 as the observed F value.

Tests of Between-Subjects Effects

Dependent Variable: Grade

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	6.829[a]	7	.976	.975	.466	.176
Intercept	2046.416	1	2046.416	2044.492	.000	.985
Course Difficulty	.311	1	.311	.311	.581	.010
Attendance	.820	1	.820	.819	.372	.025
Priority	1.627	1	1.627	1.625	.212	.048
CourseDifficulty * Attendance	1.983	1	1.983	1.981	.169	.058
Attendance * Priority	.637	1	.637	.636	.431	.019
CourseDifficulty * Priority	.033	1	.033	.033	.856	.001
CourseDifficulty * Attendance * Priority	1.419	1	1.419	1.418	.243	.042
Error	32.030	32	1.001			
Total	2085.275	40				
Corrected Total	38.859	39				

a. R Squared = .176 (Adjusted R Squared = -.005)

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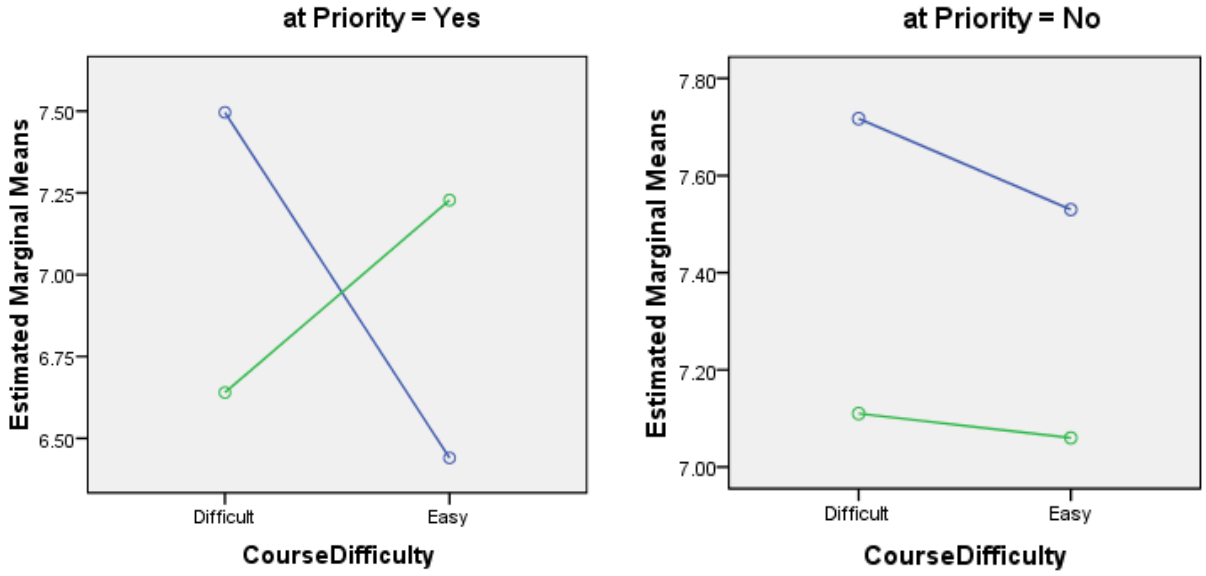

2) Since the two lines appear to be almost parallel in the second graph, we can interpret that there is no simple two-way interaction between Course Difficulty and (Attendance) Regularity. Which implies that the effect of course difficulty on Grades of the Students do not differ whether their attendance level is less than 50 or more than 50 % when the priority of the students is No(not to pursue their Art as a career).

But in first graph there seems to be a possibility of a simple two interaction being significant when Priority is Yes.

Conclusion

We conclude after the Analysis that the three factors taken by us which are Course Difficulty, Regularity and Future Priority of the Student do not have a Significant impact on the Academic Grades of the students.

After the Analyses we concluded that the factors taken up for the Experimentation were not taken are the correct levels(should have been more levels) hence the Observations obtained cannot be considered as relevant (as it gives incomplete information).

For example. If a Student belongs to Economics stream it belongs Arts stream, but its level of difficulty is same or maybe more as that of any science course. Hence levels were not appropriately considered.

Also, since the data size taken for the final analysis was 40, the sample size is very small to make concrete conclusions out of it.

References

- Design and Analysis of Experiments By Douglas C. Montgomery
- http://home.iitk.ac.in/~shalab/anova/chapter8-anova-factorial-experiment.pdf
- http://reliawiki.org/index.php/Two_Level_Factorial_Experiments
- https://statistics.laerd.com/premium/spss/ftwa/three-way-anova-in-spss-12.php