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# Reducing Errors In Slope In Physics Graphs Using Origin Lab Software

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**Abstract**

The study compared errors in slope committed by physics students using the manual method of graph plotting and Origin lab software. A descriptive survey design was adopted for the study. The study was carried out using 52 final year students (39 males & 13 females) from Physics and Astronomy department, University of Nigeria, Nsukka. Optics Practical Test (OPT) was used for data collection. Kendal Coefficient of Concordance (KCC) which yielded 0.85 reliability coefficient was used to obtain the reliability of the instrument. The mean and standard deviation of the computed errors were used to answer the research questions, while the t-test, was used to test the hypotheses at 0.05 level of significance. Findings showed that Origin lab software reduces error in slope than manual method among others. It was recommended that Origin lab computer software be adopted in plotting graphs for reduced errors in slope.

**Keywords:** Error in Slope, Physics, Graphs, Origin Lab Software, and Gender

## Introduction

Graph plotting is one of the basic skills needed for success in a Physics Education career. This is premised upon the fact that without skills in data presentation and graph plotting; success in Physics practical is incomplete. This then suggests that for a student to succeed in physics practical, s/he must acquire basic graph plotting skills. Notable among the basic graph plotting skills are labelling of axes with proper variables and their units, choice of suitable scale, plotting and location of points, and determination of the gradient of the graph among others. If all these features are properly articulated in a graph, it clearly establishes the relationship or interrelationships between or among variables of interest.

Graphs explain the nature of the relationship between or among variables, constant and the intercept. It shows pictorially, the nature of the relationship between or among variables of interest, constant and intercept. Supporting, Carrol (2013) defined graph as a diagram showing the relationship between variable quantities, typically of two variables, each measured along one of a pair of axes at right angle. It can also be defined as a pictorial representation or diagram that represents data or values in an organized manner (Carrol, 2013). These pictorial representations are usually taught manually to enable students to have a grasp of the basic skills in it.

The manual method enables students to master the basic skills involved in graph plotting. It makes students to use both their psychomotor and cognitive domains simultaneously in an attempt to drawing the graph. However, the advantage the of manual method notwithstanding, students commit some errors each time they attempt drawing graphs, leading to errors in slope. In statistics, an error (or residual) is not a "mistake" but rather a difference between a computed, estimated, or measured value and the accepted true, specified, or theoretically correct value (Australian Bureau of Statistics, 2018).

So, error is simply a deviation from the set point. It is the marginal value from the set value. Thus, one of the requirements in graph plotting is finding out the error in the slope. So students are usually asked to calculate the error in slope and add same in their reporting sheet. Observations from students' graphs have shown that no student obtains the same error in slope. This means that errors in slope obtained by different students usually differ. This implies that the use of manual method in graph plotting has some inherent defect. These errors in slope for some students are usually high. Surprisingly, the manual method is mostly used across secondary schools in Nigeria for graph plotting despite this observed defect. The manual method is also time-consuming and tedious to use. Supporting, Ainley (2011), avers that drawing neat detailed graphs is time-consuming, especially for novices or students with limited motor skills (Ainley, 2011). Interestingly, in this present 21$^{st}$ century, a time-saving emerging software with graph plotting adaptability litter the internet space waiting for download.

Graph plotting software are usually easy to use and amenable to the situation. Ainley (2000) argued that in contrast to pencil and paper graphs, graphs produced with spreadsheets are dynamic, (size, proportion and scale can be altered easily) and can be created interactively so the graph is changed as the data are modified In addition, the format and appearance of the graph can

be changed easily through the menus that control the scales, titles, labels etc. and the same set of data can be displayed quickly in various graphical forms (Ainley, 2000).

One of such software among others is ORIGIN LAB. Origin Lab is a computer program for interactive scientific graphing and data analysis (Treger, 2006). It is produced by origin Lab Corporation and runs on Microsoft windows. Graphing support in origin includes various 2D/3D plot types. Data analyses in origin include statistics, signal processing, curve fitting and peak analysis. Origin curve fitting is performed by a nonlinear least-squares fitter which is based on the Levenberg-Marquardt algorithm. Origin is primarily a Graphic User Interface (GUI) software with a spreadsheet front end. Unlike popular spreadsheets like Excel, origin's worksheet is column-oriented (Treger, 2010). Each column has associated attributes like name, units, and other user definable labels. Instead of cell formula, origin uses column formula for calculations.

Despite the advantages inherent in the use of computer software in graph plotting, it use has not been widely accepted by physics teachers, especially those teaching at secondary schools in Nigeria. Also, no study to the best of the knowledge of the researchers has investigated the efficacy of computer software (origin Lab) and manual method in reducing the error in slope during physics practicals, especially in optics. Furthermore, no study has investigated whether or not the error in slope committed by students are gender-dependent. It is upon this backdrop that the researchers posed a very important question for this study: Between manual and computer software (origin lab) which one reduces errors in slope more and what is the influence of gender on errors in slope committed by students?

In line with the purpose of the study, the following research hypotheses were formulated to guide the study and were tested at 0.05 level of significance

1. Errors in slope committed by students do not depend on the method (Manual and Origin Lab)
2. Error in slope committed by students does not depend on gender.

**Research Method**

A descriptive survey research design was adopted for the study. This was chosen because according to Nworgu (2015), the descriptive survey research design is a study that aims at collecting data on, and describing in a systematic manner, the characteristics, features or facts about a given population. These studies are only interested in describing certain variables in relation to the population. This suits the present study because it seeks to describe the error committed using computer software (origin lab) and manual method. Besides, recent studies like Eze et al. (2020), Ezema et al. (2021), Ezeaku et al. (2021), Okeke et al. (2020) Okeke, Okeke et al. (2020), Ugwuanyi et al. (2020), Okenyi et al. (2021) have adopted this design in similar studies. This study was carried out in the Department of Physics and Astronomy in the University of Nigeria Nsukka. There are 4 levels in the department (first, second, third and final year) with Physics Education students offering the course. The researchers carried out the study in this department because the students are allowed to write their exams using Computer Based Test

(CBT) or paper and pencil. The availability of large number of computers made the area appropriate for the study.

The population of the study consist of all the 512 Physics and Astronomy students in the University of Nigeria Nsukka. The number of male students and female students in the University are 460 and 52 respectively, (Department of Physics and Astronomy, University of Nigeria Nsukka). The Sample size comprised 52 students, 39 students were males while 13 students were females from one intact class (final year students)selected through purposive sampling technique. Final year students were used as the sample because almost all students in the class have a functional laptop with installed computer software (origin lab) in it and they are more knowledgeable about the computer software (origin lab).

The instrument for the data collection was a practical test titled "Optics Practical Questionnaire" (OPQ) which consist of two practical questions drawn from WAEC and Comprehensive Physics Practical Manual. OPQ consist of two sections A and B. Section A deals on the bio-data of the respondents; while Section B consisted of two major practical questions on optics. Question one deals on image formation of convex lens; while Question two consists of the image distance using triangular prism. The instrument was face-validated by two experts in the Department of Science Education, University of Nigeria Nsukka one each in Measurement and Evaluation and Physics Education respectively. The experts were asked to validate the instrument based on the appropriateness of the items and the language used. The OPQ was administered to twenty (20) University Students which were outside the sampled school. Their practical manuals were photocopied and given to three raters and subjected to scorer reliability using the Kendal Coefficient of Concordance (KCC). The reliability coefficient yielded W= 0.85. KCC was used because the scorers/raters were above two.

The instrument was administered to the students of which they followed the instructions to carry out the practical. The students were provided with laboratory apparati for optics practical, and they carried out the practical one by one. Thereafter they plotted graphs using the data obtained from the practical. Both manual method and origin lab were used to plot the graph. After the graph plotting, the researchers collected the graphs and marked them accordingly. Their scores were subjected to analysis. Error in slope was computed for the manual one using the formular for error in slope given as, S= 4W/nR; where W is the vertical scatter; R is the range in X-axis; n is the number of points plotted and 4 is a constant value. This formular was used for the manual one. The Origin lab brought out an electronic version of the errors in slope. Thereafter, overall mean and standard deviation of the computed errors were computed for the research questions, while t-test, was used to test the hypotheses at 0.05 level of significance.

## RESULTS

### Research Question One

What are the errors in slope committed by students in optics experiment using computer software (Origin Lab) and manual method?

**Table 1**

Calculated error in slope obtained using manual method and Origin Lab

| S/N | MANUAL METHOD | ORIGIN LAB | ERROR DIFFERENCE |
|---|---|---|---|
| 1 | 0.011271 | 0.00448 | 0.0068 |
| 2 | 0.008964 | 0.00389 | 0.0051 |
| 3 | 0.0088095 | 0.00416 | 0.0046 |
| 4 | 0.28106 | 0.18105 | 0.1001 |
| 5 | 0.1700 | 0.07007 | 0.0993 |
| 6 | 0.2419 | 0.1494 | 0.0925 |
| 7 | 0.6720 | 0.09217 | 0.5798 |
| 8 | 0.6170 | 0.00726 | 0.0697 |
| 9 | 0.9170 | 0.40598 | 0.5110 |
| 10 | 0.07713 | 0.02 | 0.0571 |
| 11 | 0.0300 | 0.0134 | 0.0166 |
| 12 | 0.2111 | 0.11054 | 0.1006 |
| 13 | 3.68 | 0.1017 | 3.573 |
| 14 | 0.183 | 0.0.8949 | 0.0995 |
| 15 | 2.36 | 0.31673 | 0.0433 |
| 16 | 0.025 | 0.00208 | 0.0229 |
| 17 | 0.39 | 0.00542 | 0.3846 |
| 18 | 0.021 | 0.0111 | 0.0099 |
| 19 | 0.015766 | 0.01108 | 0.0047 |
| 20 | 0.0193 | 0.01025 | 0.0091 |
| 21 | 0.024 | 0.01108 | 0.0129 |
| 22 | 0.01768 | 0.00954 | 0.0081 |
| 23 | 0.25775 | 0.17266 | 0.0851 |
| 24 | 0.01459 | 0.00706 | 0.0075 |
| 25 | 0.01408 | 0.00714 | 0.0069 |
| 26 | 1.55701 | 0.22443 | 1.3366 |
| 27 | 0.23611 | 0.15167 | 0.0844 |
| 28 | 0.04290 | 0.01482 | 0.0281 |
| 29 | 0.0330 | 0.01437 | 0.0186 |
| 30 | 0.2425 | 0.17664 | 0.0659 |
| 31 | 0.2055 | 0.17931 | 0.0262 |
| 32 | 0.3711 | 0.12899 | 0.2421 |
| 33 | 0.0896 | 0..01143 | 0.782 |
| 34 | 0.8889 | 0.10884 | 0.7801 |
| 35 | 0.1997 | 0.05066 | 0.0718 |

| | | | |
|---|---|---|---|
| 36 | 0.0760 | 0.00422 | 0.0269 |
| 37 | 0.0330 | 0.00612 | 0.0678 |
| 38 | 0.0750 | 0.00717 | 1.7676 |
| 39 | 1.7700 | 0.00245 | 0.1258 |
| 40 | 0.1480 | 0.0222 | 0.2103 |
| 41 | 0.2150 | 0.00473 | 0.0464 |
| 42 | 0.0704 | 0.0240 | 0.1029 |
| 43 | 0.2190 | 0.11606 | 0.1295 |
| 44 | 0.2490 | 0.11987 | 0.0358 |
| 45 | 0.0400 | 0.00418 | 0.1312 |
| 46 | 0.1410 | 0.00983 | 0.5099 |
| 47 | 0.5200 | 0.01001 | 0.1490 |
| 48 | 0.1240 | 0.0152 | 0.1088 |
| 49 | 0.2468 | 0.1657 | 0.0811 |
| 50 | 0.1868 | 0.0624 | 0.1244 |
| 51 | 0.2242 | 0.1011 | 0.1231 |
| 52 | 0.1812 | 0.0800 | 0.1012 |
| Average error in slope | 0.3704 | 0.0699 | 0.2536 |

Table 1 indicates that the average error committed by students using manual method is 0.3704. While the average error committed by students using Origin Lab is 0.0699.
Then the average error difference between the manual method and Origin Lab is 0.2536.
This implies that the average error committed using manual method is higher than the average error committed using computer software (Origin Lab).

**Hypothesis 1**
Error in slope committed by students does not depend on the method.

**Table 2**
t-test values of error committed by students using origin lab and manual method

| Method | N | Mean | SD | t | Df | p-value | Decision |
|---|---|---|---|---|---|---|---|
| Origin lab | 52 | 0.069 | 0.087 | -3.147 | 102 | 0.002 | Significant |
| Manual | 52 | 0.370 | 0.656 | | | | |

From Table 2, it was shown that t (102)= -3.147, p = 0.002<0.05. This indicates that p-value is less than 0.005 level of significance, indicating that the null hypothesis was not upheld. This means that the alternative hypothesis was upheld. Hence, there is a significant difference. The error in

slope committed by the students depends on method in favour of students that used origin lab. This means that origin lab reduces error in slope committed by students more than manual method.

**Research question 2**

What are the errors in slope committed by male and female students using computer software (Origin Lab) and manual method?

**Table 3a**

Calculated error in slope obtained by male students using manual method and Origin Lab.

| S/N | MANUAL METHOD | ORIGIN LAB |
|---|---|---|
| 1 | 0.011271 | 0.00448 |
| 2 | 0.008964 | 0.00389 |
| 3 | 0.00.88 | 0.00416 |
| 4 | 0.28106 | 0.18105 |
| 5 | 0.1700 | 0.07007 |
| 6 | 0.2419 | 0.1494 |
| 7 | 0.672 | 0.09217 |
| 8 | 0.617 | 0.00726 |
| 9 | 0.917 | 0.40598 |
| 10 | 0.07713 | 0.02 |
| 11 | 0.03 | 0.0134 |
| 12 | 0.2111 | 0.11054 |
| 13 | 3.68 | 0.1017 |
| 14 | 0.183 | 0.08949 |
| 15 | 2.36 | 0.31673 |
| 16 | 0.025 | 0.00208 |
| 17 | 0.039 | 0.00545 |
| 18 | 0.021 | 0.0111 |
| 19 | 0.015766 | 0.01108 |
| 20 | 0.0193 | 0.01025 |
| 21 | 0.024 | 0.01108 |
| 22 | 0.01768 | 0.00954 |
| 23 | 0.25775 | 0.17266 |
| 24 | 0.01459 | 0.00706 |
| 25 | 0.01408 | 0.00714 |
| 26 | 1.55701 | 0.22443 |
| 27 | 0.23611 | 0.15164 |
| 28 | 0.0429 | 0.01482 |
| 29 | 0.033 | 0.01437 |
| 30 | 0.2190 | 0.11606 |

| | | |
|---|---|---|
| 31 | 0.249 | 0.11987 |
| 32 | 0.04 | 0.00418 |
| 33 | 0.141 | 0.00983 |
| 34 | 0.52 | 0.01001 |
| 35 | 0.124 | 0.0152 |
| 36 | 0.2468 | 0.1657 |
| 37 | 0.1868 | 0.0624 |
| 38 | 0.2242 | 0.1011 |
| 39 | 0.1812 | 0.0800 |
| Average error in slope | 0.3642 | 0.0745 |

**Table 3b**
Calculated error in slope obtained by female students using manual method and Origin Lab.

| **S/N** | **MANUAL METHOD** | **ORIGIN LAB** |
|---|---|---|
| 1 | 0.2425 | 0.17664 |
| 2 | 0.2055 | 0.17931 |
| 3 | 0.3711 | 0.12899 |
| 4 | 0.08962 | 0.01143 |
| 5 | 0.8889 | 0.10884 |
| 6 | 0.1997 | 0.05066 |
| 7 | 0.076 | 0.00422 |
| 8 | 0.033 | 0.00612 |
| 9 | 0.075 | 0.00717 |
| 10 | 1.77 | 0.00245 |
| 11 | 0.148 | 0.222 |
| 12 | 0.215 | 0.00473 |
| 13 | 0.0704 | 0.0240 |
| Average error in slope | 0.3892 | 0.0559 |

Table 2 indicates that the average error committed by male students using the manual method and Origin Lab are 0.3642 and 0.0745 with an average difference of 0.2897. While the average error committed by female students using the manual method and Origin Lab are 0.3892 and 0.0559 with an average difference of 0.3333.
This implies that female students committed an error of 0.0436 greater than male students.

**Hypothesis 2**

Error in slope committed by the students does not depend on gender.

**Table 4**
t-test value of errors committed by male and female students using origin lab and manual method

| Gender | N | Mean | SD | t | df | p-value | Decision |
|---|---|---|---|---|---|---|---|
| Male | 39 | 0.216 | 0.524 | 0.102 | 102 | 0.919 | NS |
| Female | 13 | 0.204 | 0.366 | | | | |

From Table 4, it was shown t-value $_{(df=102)}$ =0.102, p = 0.919>0.05. This indicates that p-value is greater than 0.005 level of significance, indicating that the null hypothesis was upheld. Hence, there is no significant difference. The error in slope committed by the students does not depend on gender.

**Discussion**

Finding revealed that the error in slope committed by students that used origin lab application to plot their graph are much smaller compared to those students that used manual method to plot their graph. Hypothesis 1, indicates that there is a significant difference in the method used. Origin Lab is a computer program for interactive scientific graphing and data analysis. It is produced by origin Lab Corporation, and runs on Microsoft windows. The students that made use of it, obtained lesser error than those that used manual method. This was so, because some students find it difficult to choose scales and locate points from graph sheet when plotting with manual method. This is in agreement with Ugwuanyi and Ugwuanyi (2018), who conducted a research work on graph plotting skills in electricity practical, they found out that students possess poor skills in plotting points, line of best fit, triangle, slope, interpretation, intercept, precaution and evaluation. Also, Telima (2013) conducted research work on difficulties students encounter in reporting physics practicals, the result of the study revealed that there was insufficient physics apparatus in the schools, students lack understanding of instructions during physics practical activities, students are not able to tabulate obtained values appropriately, scale choosing is a major problem encountered by students while interpreting data graphically. In origin lab, it has been programmed in a such a way that students input the values gotten from the experiment and click on “plot” the computer software automatically chooses the scale and plots the graph.

Also, finding showed that there is no significant difference in error in slope committed by both gender group. Hence, the error in slope committed by the students does not depend on gender. This could be explained by the fact that practicals are hands-on related, thus both males and female students who mastered the process can perform it with ease and with minimal error. This is in agreement with Agbo and Dike (2012), who carried out a study on gender in relation to graph plotting in mathematics, they observed that the result showed an insignificant difference between males and female in relation to graph plotting.

## Conclusion

From the results obtained in the study on reducing error in a slope using computer software (origin lab) in optics practical, it was found that the students that used computer software (origin lab) obtained error that is much smaller than the students that used manual method, the result also showed that the error committed by the students does not depend on gender.

## Recommendations

The following recommendations were made given the findings of the study:

i) Physics teachers should be encouraged through in-service training, seminars and other forms of training on the job to employ computer software (origin lab) in plotting of graphs.

ii) Since the use of computer software (origin lab) has been found to reduce error in slope than manual method of plotting graph, Physics teachers are should be encouraged to employ it in plotting of graphs in all topics in physics. By so doing, it will increase the students' interest in physics.

iii) Teachers education programmes in colleges of Education and other tertiary institutions should be made to inculcate in students the processes of using computer software (origin lab).

iv) Physics teachers should pay greater attention to the issue of gender differences in physics classrooms. They should as much as possible eliminate content, instructional techniques and material that will bring about gender differences in the classroom.

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