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Research paper

Discovery of misleading graph titles at many places of the traditional scientific literature

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Abstract

This paper emphasizes the urgent need of making use of well-defined self-explanatory graph title in representing a graph in graph drawing. A lot of misleading graph titles, none of which is in accordance with the traditional convention in regard to assignment of title to a graph, has been found to prevail at many places of the traditional scientific literature. With a view to ensuring quality graphing, urgent need of getting rid of those misleading graph titles with simultaneous incorporation of self-explanatory ones (following traditional convention in the said context) has also been emphasized.

Keywords: *Dependent variable; Graph drawing; Independent variable.*

1. Introduction

It is well known that Graphs are an excellent way for the pictorial representation of data and they help to visualize the patterns and trends of variation within the data as well. They also help in making effective analysis of scientific data. A graph basically summarizes the nature of variation of one quantity as another quantity depending on it changes. It essentially summarizes a good deal of information into one picture. On account of these reasons, scientists are often in need of representing the data in the graphic form.
On account of the importance of graphs from the view point of scientific interest, care must be taken to see that a graph drawn is always self-explanatory and easily readable, so that such a graph drawn might enhance rather than confuse any one about the understanding of the research. Several graph drawing instructions and guidelines [5], [6], [9], [10], [15], [22], [23], [24] for quality graphing exist in the traditional literature. Among many others, some of the essential qualities of a good graph are: (i) Graph drawn must have a well defined "Title" or a well defined "Caption" of the Figure related to the graph so that it clearly conveys what the graph actually represents; (ii) X and Y axes should be properly specified; (iii) The independent variable (i.e. the quantity which can be changed arbitrarily during the experiment) is to be plotted along X-axis, and the dependent variable (i.e. the quantity whose dependence is being studied in the experiment) is to be plotted along Y-axis; (iv) Units of the quantities are to be specified along the respective axes of coordinates.
This paper is concerned only with "Graph title". A revisit has been made to the International convention in regard to titling a graph [5], [6], [9], [10], [15], [22], [23], [24] first. Examples of some typical graphs with well defined titles are subsequently offered. Thereafter, a good number of graphs in the traditional literature have been examined to discover the fact that the "Graph title" in each of them violates the International convention in regard to "Graph title". Such anomalies must be taken serious care of and getting rid of such confusing graph titles from the relevant field of study by simultaneous replacement with self-explanatory graph titles is essential for the clarity of understanding and development of fault-free concept in respect of graph drawing.

2. Traditional convention regarding graph title

Writing down the title of a graph is mandatory in scientific literature [9], [10], [11], [12], [19], [21], [24]. This title may be written on the top side of the/graph/graph paper, or it may be written as a caption of the Figure number allotted to the graph just below the graph paper.
The quoted lines "All graphs should include a title that summarizes what the graph shows. The title should identify what is being described (e.g. speeding offences detected by automatic cameras) and the units of measurements (e.g. percentages, total number, frequency). The title may be placed within the chart area, as in the example above, or above or below the chart." in regard to graph title exist in [21].
Making use of a graph title something like the dependence of the dependent variable on the independent variable has been emphasized in [9].
The quoted lines "A good graph has a title that describes what is being plotted." regarding graph title prevail in [19]. In the section "Layout and presentation" of [12], the following quoted lines exist. "Every graph must have a figure number and a title. If possible the title should be placed underneath the graph as with other diagrams, but computer packages for plotting graphs usually put the title at the top."
The quoted lines "Graphs should carry a figure number (in the same sequence as the numbering of diagrams – see below) and a title in the form of a caption (see section 3.4.3). All graphs should be referred to within the text." under the section "Graphs and tables" in page number 8 have been found to exist in [11]. The author in [24] opined that "Graphs should always have at the minimum a caption, axes and scales, symbols and a data field.".

Furthermore, in section 7.2 of [10], the following quoted lines exist.
"The graph must have a descriptive title or caption, clearly stating what the graph illustrates."
It thus readily follows from above that writing down a proper self-explanatory title of a graph is mandatory as per traditional convention of graphing so that a reader can easily understand the graph without asking what it actually represents.

3. Some typical graphs with self-explanatory titles

Examples of some typical graphs, each with appropriate self-explanatory title as well as caption of relevant Figure number are now being provided below.
Fig. 1 represents a typical graph showing the nature of variation of the potential difference across a metallic conductor with the change of electric current through it with appropriate graph title and caption.
The nature of variation of the elongation of a string of elastic material with the change of applied load, obtained by Searle's method of determination of Young's modulus, is shown in Fig. 2 with self-explanatory graph title as well as caption.

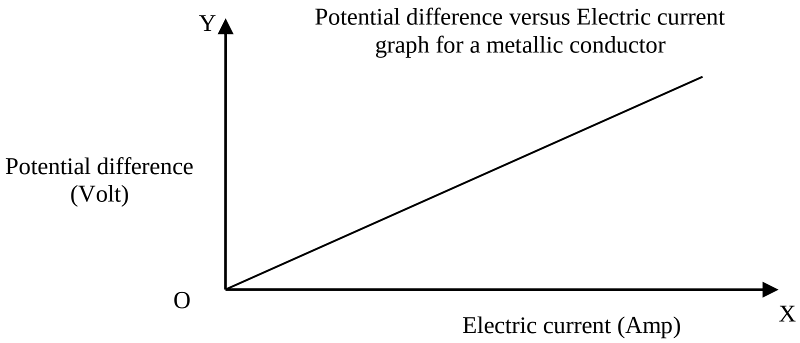

Fig. 1: A typical graph showing the dependence of potential difference across a metallic conductor on the electric current passing through it.

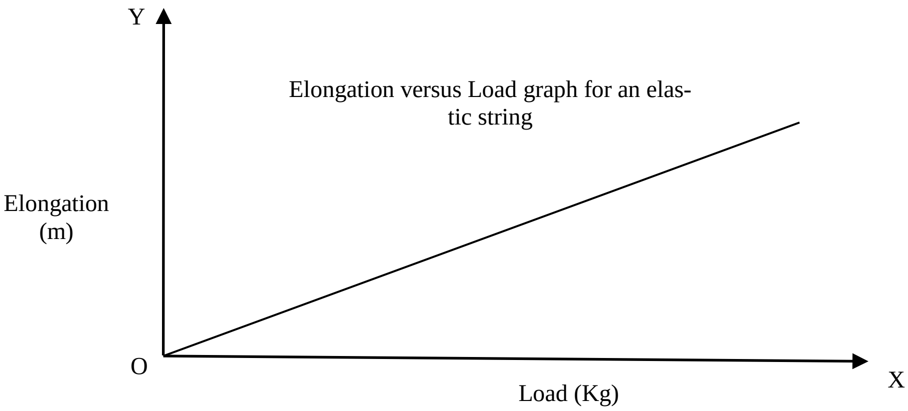

Fig. 2: A typical graph showing the dependence of elongation of an elastic string on the applied load.

Fig. 3 below shows a typical graph (with appropriate graph title and caption) in which the trend of variation of the angle of deviation with the change of the angle of incidence for a prism with specific refracting angle has been reflected.

Fig. 4 below represents a typical graph (with appropriate graph title as well as caption) in which the nature of variation of the square of the time period of a simple pendulum with the change of its effective length has been reflected.

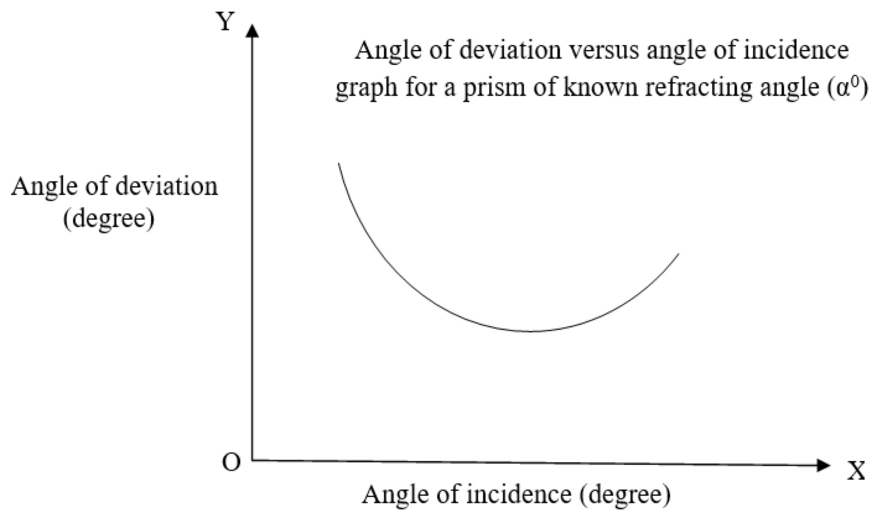

Fig. 3: A Typical Graph Showing the Dependence of the Angle of Deviation on the Angle of Incidence for A Prism of Known Refracting Angle (A0).

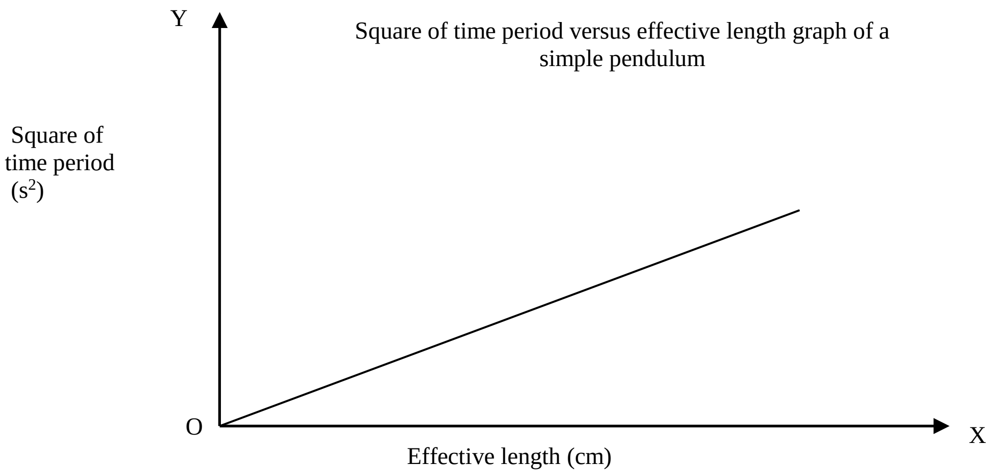

Fig. 4: A typical graph showing the dependence of the square of time period of a simple pendulum on its effective length.

4. Anomalies observed at many places of the traditional literature regarding graph title

Although many standard literature [5], [6], [9], [15], [22], [23], [24] follow the rule in respect of assigning a “Title” to a graph or in writing down the “Caption of Figure related to the graph” as has been mentioned earlier, violation of the above rule in respect of assigning the “Title” to a graph or in writing down the “Caption of the Figure related to a graph” has been observed at many other places of the traditional literature [8], [13], [14], [16], [18], [20], [25].

Let us consider first the graph shown in Fig. 2-7, page 43 of [13], in which plate voltage is plotted along X-axis and plate current is plotted along Y-axis, the caption of the said figure being “A typical volt – ampere characteristic for a diode, showing the Schottky effect." This caption is not in accordance with the traditional convention of graph drawing, and one of the correct captions of the said graph might be “A typical ampere – volt characteristic for a diode, showing the Schottky effect." Similarly in each of Figure 4 and Figure 5 of [14], voltage is plotted along X-axis, and current is plotted along Y-axis but the caption of each of those Figures contained the words “The V-I characteristic", which basically violates the traditional convention in such regard, and that has to be replaced by the words “The I-V characteristic” to get rid of the relevant ambiguity. Furthermore, in each of Figure 3 - Figure 7 as well as in each of Figure 9 – Figure 14 of [7], voltage is plotted along X-axis, and current is plotted along Y-axis but the caption of each of those Figures contained the words “The V-I curve(s)”, which is basically a misleading one and that has to be replaced by the words “The I-V curve(s)” to get rid of the relevant ambiguity.

Let us now consider the graphs shown in Fig. 2 of [1]. In drawing the graphs shown in Fig. 2 of [1], extension (mm) is plotted along X-axis and shear force (N) is plotted along Y-axis. The caption of Fig.2 of [1] is: Typical force-extension curve for three types of Velcro. It may be noted that here shear force is the independent variable quantity, and the extension is the dependent quantity. So, the selection of the dependent parameter “Extension” along X-axis and the independent parameter “Shear stress” along Y-axis for drawing the said graphs shown in Fig. 2 of [1] is not at par with the traditional convention of drawing graphs. Furthermore, the words “force-extension” in the caption of Fig. 2 needs to be replaced by the words “Extension-force” graph when the graph is drawn considering the Shear force along X-axis and Extension along Y-axis.

Again, the quoted lines concerning Figure 1.7 in page number 6 of [4] are: “If a tensile force applied to a uniform bar of mild steel is gradually increased and the corresponding extension of the bar is measured, then provided the applied force is not too large, a graph depicting these results is likely to be as shown in Figure 1.7.” Now, it may be noted that in this case, force is the independent variable, and extension is the dependent variable. So, as per usual convention of graph drawing, in Figure 1.7 of [4], force should have to be plotted along X-axis, and extension should have to be plotted along Y-axis. Thus by selecting extension along X-axis, and force along Y-axis for drawing the graph in Figure 1.7 of [4], the usual convention of graph drawing has been violated.

In Fig. 4.11, page 118 of [8], Time in mins. is plotted along X-axis and Temperature in ^{0}C is plotted along Y-axis, the caption of the said figure being Time – temperature graph. This is very much misleading, and one of the proper captions of the said figure might be "Temperature versus Time graph during heating."

If we consider Fig. 6.30, page 220 of [8], we find that, Incident angle (i) is plotted along X-axis and Angle of deviation (D) is plotted along Y-axis, the caption of the said figure being "(i-D) curve." Such a caption is very much misleading and one of the correct self-explanatory captions of the said figure might be "(D-i) curve of a prism having refracting angle x^0," where the value of 'x' has to be specified, without which the said title would have no meaning at all.

In a similar manner, in Fig. 2 of [25], Angle of incidence is plotted along X-axis and Angle of deviation along Y-axis, the caption of Fig. 2 being "The i-d curve for A = 40^0, 50^0, 60, and 70." Such a caption has no meaning at all, and hence it is very much irrelevant. One of the easily readable captions of the said Fig. 2 of [25], might be "The d versus i curves of prisms with A = 40^0, 50^0, 60^0, and 70^0."

In Fig. 3.24, page 88 of [8] regarding determination of a coefficient of viscosity of a liquid by its flow through a capillary tube, Height (h) is plotted along X-axis and Rate of flow (V) is plotted along Y-axis. The caption of Fig. 3.24 is "(h-V) graph." This is neither a correct caption as per traditional graph drawing convention nor self-explanatory at all. One of the appropriate captions for the said figure might be "(V-h) graph in relation to streamline flow of a liquid through a long narrow tube."

In Fig. 9.23, page 342 of [8], Temperature in ^{0}C is plotted along X-axis and Thermo e.m.f. in mV is plotted along Y-axis, the caption of the Figure being Temp – thermo e.m.f. curve. This is very much misleading, and it violates the traditional convention in such regard. One of the appropriate captions for the aforesaid figure might be "Thermo e.m.f. versus temperature curve of a thermocouple."

In the graph shown in Fig. 2.19, page 74 of [16], Pressure in cms of mercury is plotted along X-axis and Volume in c.c. is plotted along Y-axis, the title of the graph being "(P-V) curve". This is not at all a proper one. One of the appropriate titles for such a graph might be "(V-P) curve for a gas at constant temperature".

Though in Fig. 2a of [20], "Dose" is plotted along X-axis and "Response" is plotted along Y-axis, the caption of Fig. 2 is "Dose-response curves derived from experiments of nature." This caption is not at all a proper one. One of the appropriate captions of the said figure might be "Response versus Dose curves derived from experiments of nature."

In Fig. 8(b) of [18], Fall time (s) is plotted along X-axis and Magnet vertical distance (cm) is plotted along Y-axis, the caption of Fig. 8(b) being "Graph of fall time against Vertical distance of the falling magnet." This is basically wrong, and the correct caption of Fig. 8(b) would be "Graph of the vertical distance of the falling magnet versus the fall time."

In Fig. 2.15, page 49 of [17], in connection with determination of acceleration due to gravity by simple pendulum, T^2 is plotted along X-axis, and l is plotted along Y-axis, the caption of the said figure being "Graph of l versus T^2." This is basically flawed because in this case, l is the independent variable, and T is the dependent variable. So, we must plot l along X-axis and T^2 along Y-axis, the correct caption of the said figure will then be "Graph of T^2 versus l for a simple pendulum."

5. Conclusion

This paper emphasizes the urgent need of using the well-defined, self-explanatory, easily readable good title of a graph in graphing. The traditional convention [9], [10], [11], [12], [19], [21], [24] in respect of assigning a title to a graph in graph drawing has been considered first. It would be worth mentioning here that such a convention in assigning a title to a graph for quality graphing is being followed at many places of the traditional literature [5], [6], [9], [10], [15], [22], [23], [24]. Examples of a few graphs, each with a good and proper title have been incorporated as ready reference. Existence of graph titles at many other places of the long-running literature [7], [8], [13], [14], [16], [18], [20], [25], violating the traditional convention in the said context has been detected and one self-explanatory graph title for each of them has also been proposed. From the view point of clarity of understanding and ensuring quality graphing, getting rid of those misleading graph titles which are not in accordance with the traditional convention of graph drawing is essential and needs immediate attention.

The author himself feels that the titles as well as the captions of Figures related to the graphs in some of his earlier works [2], [3] have not been considered as per traditional convention and hence those titles/captions should have to be reconsidered as per traditional convention in such regard as well.

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